



180's v.1

Investment Strategy Testing Summary

The **180's strategy** is short-term a **swing trading** investment technique developed by **Jeff Cooper**. It uses a **two-day reversal pattern** within an ongoing trend, with the goal of identifying when a **short-term pullback presents an opportunity to open a long position**. This is an approach that follows the prevailing trend but uses **short-term corrections** to enter a position at a more favorable price.

The strategy was tested on **parameters suggested by the strategy creator, Jeff Cooper**:

- **Short Moving Average (SMA) Length:** 10 days;
- **Long Moving Average (SMA) Length:** 50 days;
- **Formation candle:**
 - **The closing price of the first candle** is in the **lower 25% of the daily range and below the opening price**;
 - **The closing price of the second candle** is in the **upper 25% of the daily range and above the opening price**;
 - **The closing price of the second candle** is **above both the 10-day and 50-day moving averages**;
- **Stop loss:** 1 tick below the price low of the candlestick formation;
- **Method of opening a position:** one tick above the high of the candlestick formation;
- **Position size:** corresponding to a risk of 1.0% of total capital;
- **Position direction:** long positions (buy) only.

It should be noted that while the strategy's results on in-sample data are decent, the strategy failed the stability test in a wide range of optimized parameters. This means that the strategy loses its profitability and generates a significantly larger drawdown when tests are conducted on suboptimal parameters. Therefore, it is not recommended to use it in real transactions.

Our goal is to have a strategy that remains **profitable and effective over a wide range of parameters**, because the market is a changing organism and the optimal parameters can change over different periods. I cannot emphasize enough that for a strategy to work in real conditions, it must also work on suboptimal parameters and in suboptimal conditions. In a word - **it must be stable** to changing market conditions.

I don't know who said these words, but they perfectly reflect the problem of many optimizations:

"I've never seen a strategy that didn't work in backtests."

We don't know the future, we don't know future market conditions, but if we know that our strategy **has historically generated acceptable results** in various market conditions and across various parameter ranges, then we are **one step ahead of other** market participants.



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Step 1: Formulate an investment strategy

180's is a **short-term investment strategy** developed by **Jeff Cooper** that is based on the analysis of **one-day trend reversals and continuation of the move** in the direction of the original trend.

The strategy uses a **two-day reversal pattern** within an ongoing trend, and its goal is to identify when a **short-term pullback presents an opportunity to open a long position**. It is an **approach that follows the prevailing trend but uses short-term corrections** to enter a position at a more favorable price.

Strategy assumptions:

- The strategy identifies **short-term reversals** after which **the trend should resume**;
- Positions are opened **only in the direction of the trend** – the strategy focuses on **long positions**;
- Key entry conditions are based on **candle closes relative to the daily range** (candlestick formation).

The strategy involves **entering a long position** when a **candlestick formation is formed**, taking advantage of a potential **price rebound**.

Characteristics of the strategy and its strengths and weaknesses:

- **Simple signal identification** – based on price analysis and moving averages, without the need to use additional indicators;
- **Using market momentum** – positions are opened based on strong price movements, which increases the probability of a successful trade;
- **Clear risk management rules** – using stop loss orders allows you to limit losses in the event of a signal failure;
- **False signals in case of a dynamic trend change** – during periods of a rapid trend change the strategy may generate losing signals.

To test the above strategy, we will make the following **changes and extensions**:

- **Instead of stocks and ETFs**, tests were performed on **stock indices, bonds, gold and the dollar index**;
- **Stop loss** was set below the price low of the candlestick formation;
- **The position** is closed after **the stop loss order is activated**. or when the price falls below a longer moving average.

Jeff Cooper's 180's strategy is a **one-day reversal and trend continuation** approach. It uses **simple but effective price rules** and by filtering positions with **moving averages**, it avoids false signals.

Its main advantages are **ease of implementation, clear rules and compliance with market momentum, but appropriate risk management** remains crucial.



Step 2: Define investment principles

Below is the **pseudocode** for the **180's strategy** on daily data:

- 1. Candlestick pattern (candle formation):**
 - a. **On the first day**, the closing price must be within **the lower 25% of the daily range and below the opening price**.
 - b. **On the second day**, the closing price must be within **the upper 25% of the daily range and above the opening price**.
- 2. Trend Confirmation:** The second day's closing price must be above both the 10-day and 50-day moving averages, confirming an uptrend.
- 3. Entry into position:** On the third day, a position is opened one tick above the high of the candlestick formation.
- 4. Conditions for closing a position:**
 - a. **Loss Order:** Initial stop loss is set at 1 tick below the price low of the candlestick formation.
 - b. **Trailing stop:** Price falls below the 50-day moving average.
- 5. Daily monitoring:**
 - a. The conditions for opening positions and executing orders are checked every day.
 - b. The system checks whether the entry conditions are met and whether the stop loss should be moved.
- 6. Additional notes:**
 - a. **No Short Positions:** The strategy focuses only on long positions in an uptrend.
 - b. **Financial Instruments:** For the purposes of this test, **long positions on stock indices, bonds, gold and the dollar index were used**.

The above rules have been described in a way that allows them to be directly converted into a script in the chosen testing platform, which ensures the accuracy of the historical simulation and the reliability of the test results.

The tests are carried out assuming that the risk of one position is **1.0% of the total capital**, with a **stop loss order** set below **the price low of the candlestick formation**.



Step 3: Conduct a preliminary test of the investment strategy

Below are some purchase and sale transactions that allow you to verify the following aspects:

- **Correctness of generated signals;**
- **Direction of opening position;**
- **Moment of opening a position;**
- **Position opening price;**
- **Moment of closing the position;**
- **Closing price of the position;**
- **Compliance of the transaction with the theoretical assumptions of the investment strategy.**

At this stage **it does not matter** whether the transactions are **profitable**, what **instrument was used** or whether they took place **recently** or **in the distant past**. The key is **to check whether the transactions are generated correctly** and in accordance with the assumptions described in the previous step.

The first transaction was made on a **Nasdaq 100 futures contract**. In early October 2024, **the contract fell** and **the closing price was in the lower 25% of the daily range** (first candle in the rectangle on the left). Additionally, **the closing price of this candle was lower than the opening price**, confirming short-term downward pressure. The next day, **the closing price was in the upper 25% of the daily range** and **exceeded the opening price** (second candle in the rectangle on the left). In addition, the closing price of this candle fell **above the 10-day and 50-day moving averages**. **The position was opened the next day** when the price rose **above the high of both candles** (third candle in the rectangle on the left). **The stop loss was set at the low of both candles (red dot)**, which limited the risk of loss in the event of a signal failure.

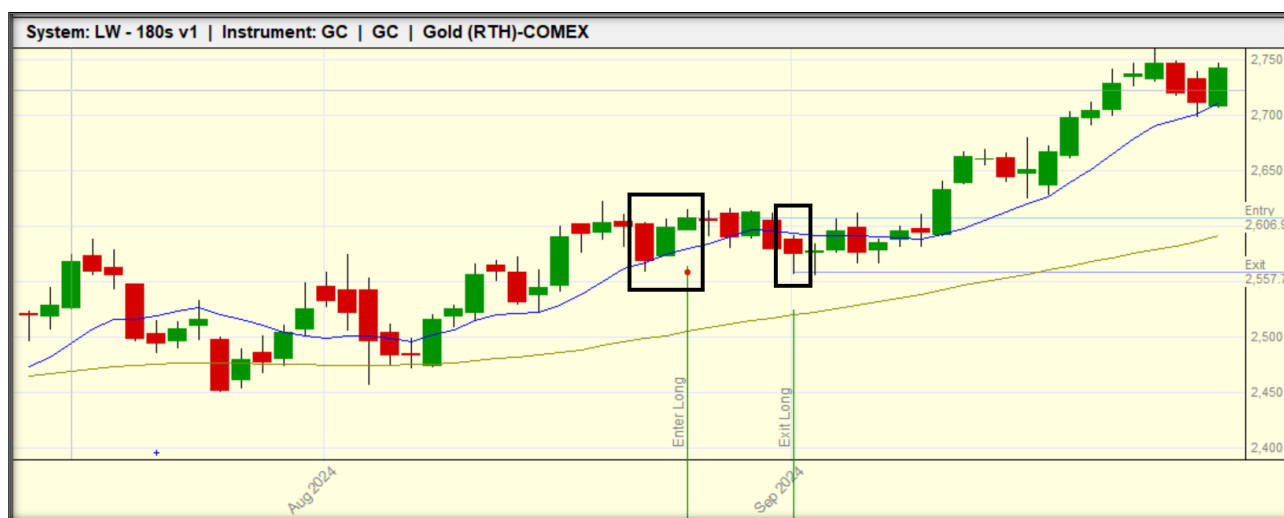
In mid-December 2024, **after several dozen days of growth**, **the price of the futures contract fell sharply**. **High market volatility** in the following days led to the activation of the **Trailing Stop order**, which was set at the level of **the 50-day moving average**. **The position was closed** (candle in the rectangle on the right). **The system worked correctly**.





The second transaction was made on a **gold futures contract**. At the end of August 2024, **the contract fell** and **the closing price was in the lower 25% of the daily range** (first candle in the rectangle on the left). Additionally, **the closing price of this candle was lower than the opening price**, confirming short-term downward pressure. The next day, **the closing price was in the upper 25% of the daily range** and **exceeded the opening price** (second candle in the rectangle on the left). Furthermore, the closing price of this candle fell **above the 10-day and 50-day moving averages**. **The position was opened the next day** when the price rose **above the high of both candles** (third candle in the rectangle on the left). **The stop loss was set at the low of both candles (red dot)**, which limited the risk of loss in the event of a signal failure.

After a few days, gold prices **fell, activating the original stop loss order**. **The position was closed** (candle in the rectangle on the right). **The system worked correctly**.



Once we are sure that the transactions are generated correctly, we can proceed to the first test of the strategy on the full **in-sample data set**. These tests are conducted on **the basic parameters** that were **proposed by the creator, Jeff Cooper**.

First of all, **we reject strategies that linearly lose capital**. If a strategy exhibits such a pattern, it is a clear signal that any parameter optimization does not make sense.

Our basic expectation is that the strategy generates **positive results**, even if they are at a low level.

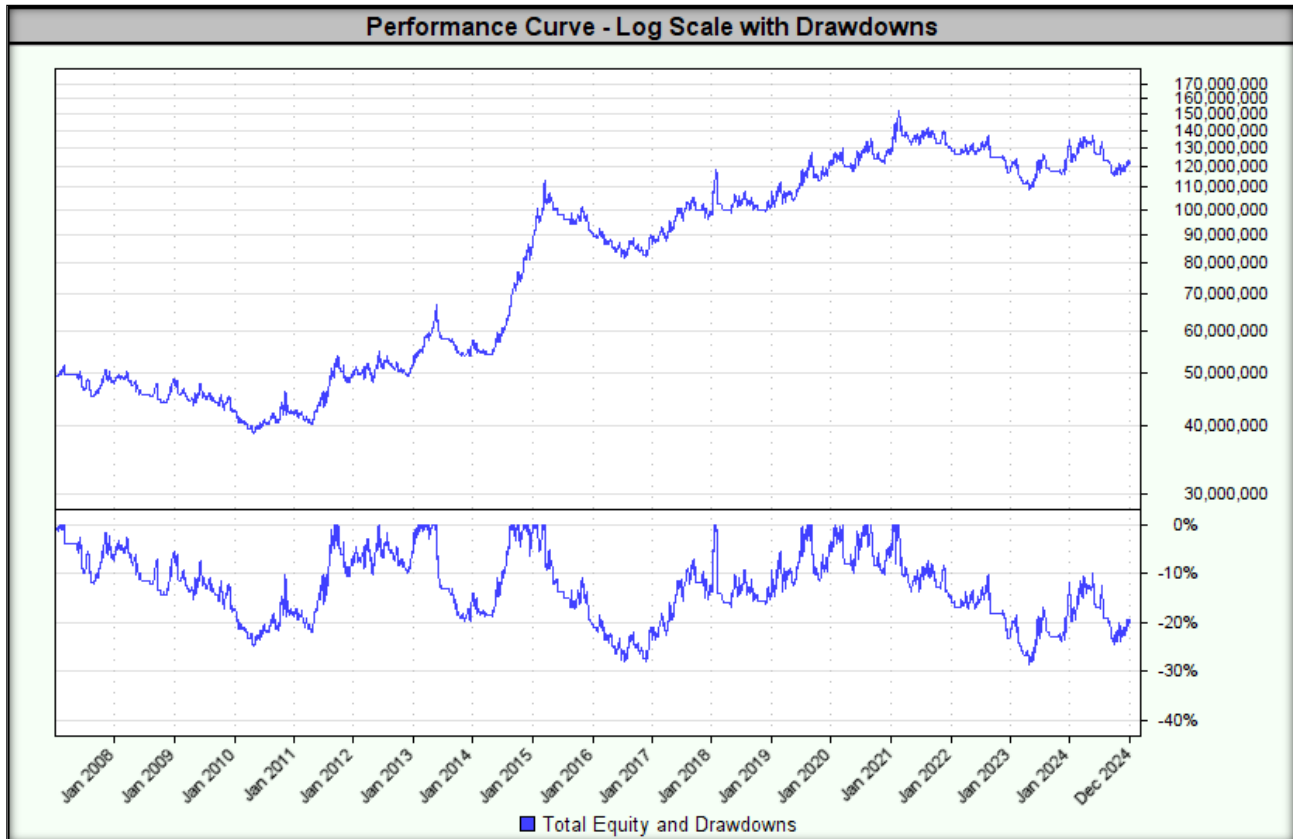
Tested base parameters:

- **Short Moving Average (SMA) Length:** 10 days;
- **Long Moving Average (SMA) Length:** 50 days;
- **Formation candle:**
 - **The closing price of the first candle** is in **the lower 25% of the daily range** and **below the opening price**;
 - **The closing price of the second candle** is in **the upper 25% of the daily range** and **above the opening price**;
 - **The closing price of the second candle** is **above both the 10-day and 50-day moving averages**;
- **Stop loss:** 1 tick below the price low of the candlestick formation;



- **Method of opening a position:** one tick above the high of the candlestick formation;
- **Position size:** corresponding to a risk of 1.0% of total capital;
- **Position direction:** long positions (buy) only.

The test result is shown below.



| Indicators/Measures | Concluding a transaction at the opening price |
|-------------------------------|---|
| CAGR% | 5.1% |
| MAR Ratio | 0.18 |
| RAR% | 8.0% |
| R-Cubed | 0.15 |
| Robust Sharpe Ratio | 0.59 |
| Max Drawdown | 28.5% |
| Wins | 25.4% |
| Losses | 74.6% |
| Average Win% | 3.57% |
| Average Loss % | 0.84% |
| Win/ Loss Ratio | 3.83 |
| Average Trade Duration (days) | 29 |
| Percent Profit Factor | 1.44 |
| SQN | 0.37 |
| Number of transactions | 445 |



In summary, the system works properly and generates signals as expected. Additionally, tests on basic parameters have yielded satisfactory results. We can now move on to the most interesting stage of creating an investment strategy – **optimization**.



Step 4: Optimization and assessment of investment strategy stability

Strategy 180's v.1 assumes the use of parameters optimized by Jeff Cooper. This means that we do not optimize the parameters themselves, but only examine whether the strategy behaves stably on in-sample and out-of-sample data.

1. Stability across a wide range of optimized parameters

In the first step, we test the stability of the parameters on the in-sample data. For this purpose, we determine the ranges of values for all optimized parameters so that the quotient of the highest and lowest values of the range was at least 150%.

In the tested strategy, the ranges defined in this way are:

- Short Moving Average (SMA) Lengths: Range 8-12 days (step: 1);
- Long Moving Average (SMA) Lengths: 40-60 day range (step: 2);
- Formation candle:
 - Lower closing range of the first candle: range 20%-30% (step: 1 pp.);
 - Upper closing range of the second candle: range 20%-30% (step: 1 pp.).

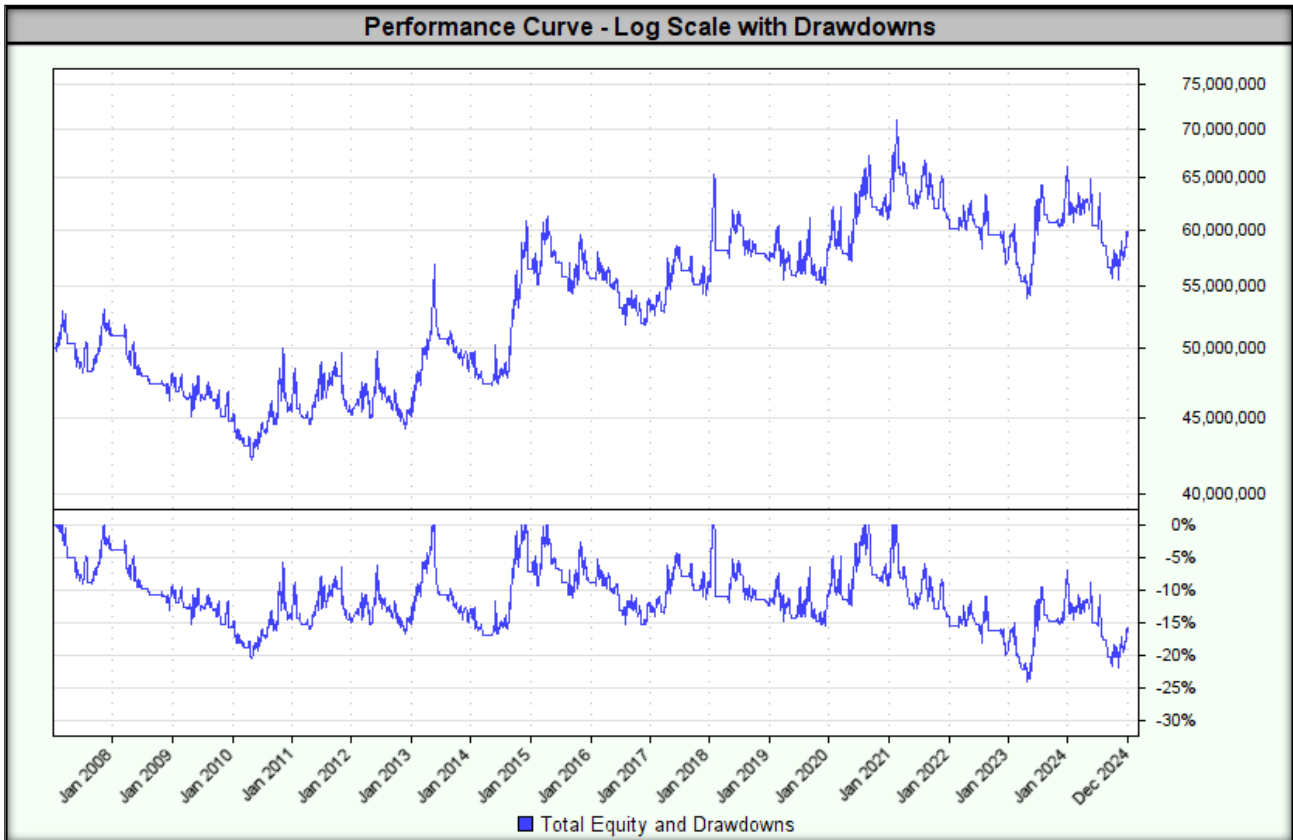
The purpose of this test is to check whether the strategy remains stable (robust) over a wide range of parameters, which will allow to assess its usefulness in real market conditions. The key evaluation criterion is that all test results show a positive MAR value, and the maximum drawdown does not exceed 250% of the drawdown value for the result with the highest MAR. If any test generates a negative MAR value or if the drawdown exceeds 250% of the drawdown value for the result with the highest MAR, the strategy is completely rejected.

The lowest MAR value of 0.04 was achieved for the following parameters:

- Short Moving Average (SMA) Lengths: 12;
- Long Moving Average (SMA) Lengths: 40;
- Formation candle:
 - Lower closing range of the first candle: 20%;
 - Upper closing range of the second candle: 24%.

| Test | Moving Average Short (days) | Moving Average Long (days) | Bottom Range Close (%) | Top Range Close (%) | End Balance | CAGR% | MAR | Sharpe | Ann. Sharpe | Max TE DD | Longest DD |
|------|-----------------------------|----------------------------|------------------------|---------------------|-----------------|-------|------|--------|-------------|-----------|------------|
| 5331 | 12 | 40 | 20% | 76% | \$59,874,954.12 | 1.01% | 0.04 | 0.15 | 0.16 | 24.1% | 65.9 |
| 5342 | 12 | 40 | 21% | 76% | \$61,581,661.54 | 1.16% | 0.05 | 0.16 | 0.17 | 25.4% | 74.3 |
| 5332 | 12 | 40 | 20% | 77% | \$62,113,939.34 | 1.21% | 0.05 | 0.17 | 0.20 | 24.1% | 74.3 |
| 5330 | 12 | 40 | 20% | 75% | \$62,535,716.63 | 1.25% | 0.05 | 0.17 | 0.20 | 24.1% | 65.7 |
| 4000 | 11 | 40 | 20% | 76% | \$62,721,898.81 | 1.27% | 0.05 | 0.17 | 0.21 | 24.1% | 65.9 |
| 5825 | 12 | 48 | 21% | 75% | \$67,376,689.45 | 1.67% | 0.05 | 0.20 | 0.19 | 31.7% | 117.7 |
| 5343 | 12 | 40 | 21% | 77% | \$63,555,599.08 | 1.34% | 0.05 | 0.18 | 0.20 | 25.2% | 74.3 |
| 5826 | 12 | 48 | 21% | 76% | \$67,411,866.80 | 1.67% | 0.05 | 0.20 | 0.18 | 30.8% | 117.7 |
| 3152 | 10 | 48 | 20% | 75% | \$68,738,011.63 | 1.78% | 0.06 | 0.21 | 0.24 | 32.3% | 117.7 |

Below is a graph of the equity curve for the strategy with the lowest MAR.



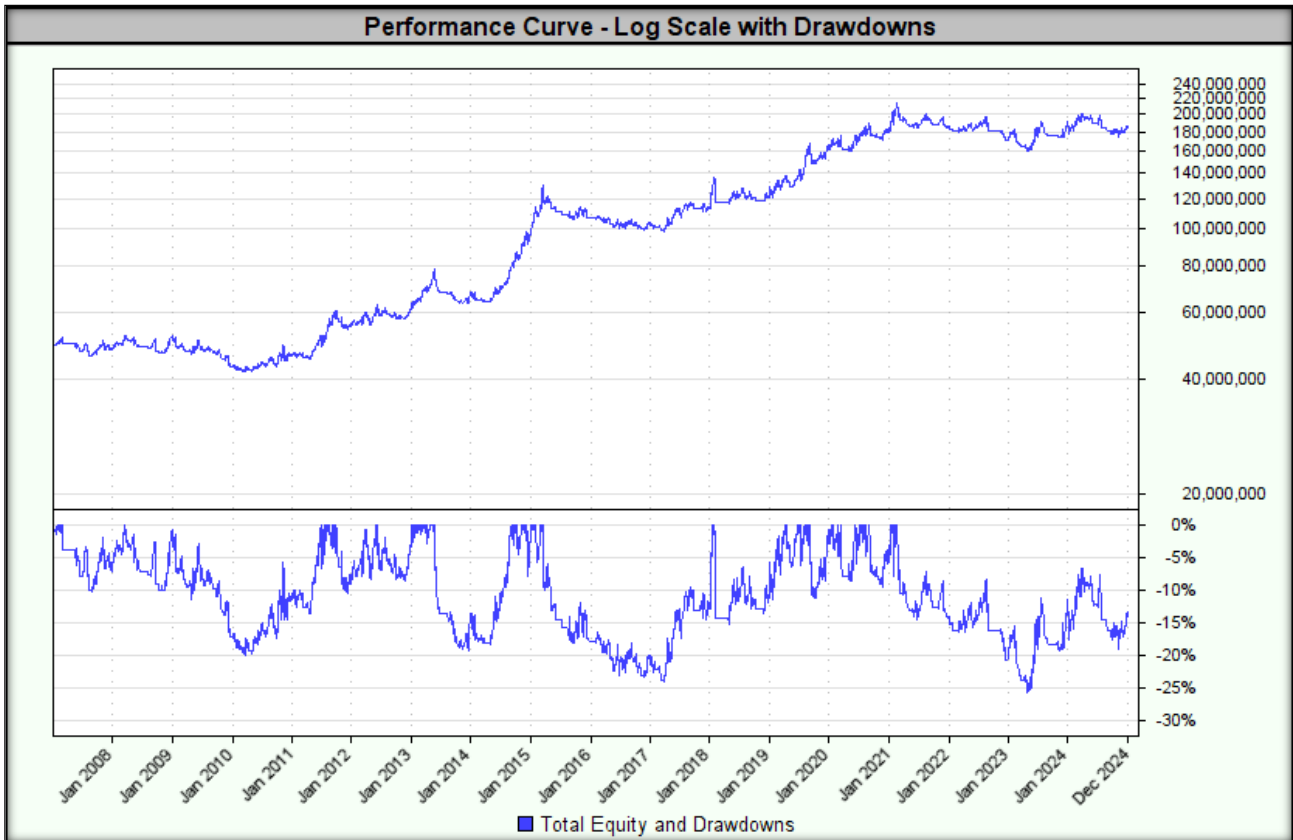
The highest MAR value of 0.29 was achieved for the following parameters:

- Short Moving Average (SMA) Lengths: 9;
- Long Moving Average (SMA) Lengths: 52;
- Formation candle:
 - Lower closing range of the first candle: 24%;
 - Upper closing range of the second candle: 20%.

The highest MAR value was accompanied by a drawdown of 25.8%.

| Test | Moving Average Short (days) | Moving Average Long (days) | Bottom Range Close (%) | Top Range Close (%) | End Balance | CAGR% | MAR | Sharpe | Ann. Sharpe | Max TE DD | Longest DD |
|------|-----------------------------|----------------------------|------------------------|---------------------|------------------|-------|------|--------|-------------|-----------|------------|
| 2112 | 9 | 52 | 24% | 80% | \$186,619,014.81 | 7.59% | 0.29 | 0.62 | 0.56 | 25.8% | 46.4 |
| 1990 | 9 | 50 | 24% | 79% | \$175,416,673.70 | 7.22% | 0.29 | 0.60 | 0.58 | 24.6% | 53.0 |
| 2111 | 9 | 52 | 24% | 79% | \$184,445,767.41 | 7.52% | 0.29 | 0.61 | 0.56 | 25.6% | 46.4 |
| 1265 | 8 | 60 | 24% | 80% | \$187,812,408.10 | 7.63% | 0.29 | 0.60 | 0.65 | 26.0% | 46.4 |
| 1991 | 9 | 50 | 24% | 80% | \$177,626,998.64 | 7.30% | 0.29 | 0.61 | 0.58 | 25.0% | 53.4 |
| 2596 | 9 | 60 | 24% | 80% | \$193,880,980.92 | 7.82% | 0.29 | 0.61 | 0.58 | 26.8% | 51.4 |
| 1264 | 8 | 60 | 24% | 79% | \$186,918,972.03 | 7.60% | 0.29 | 0.60 | 0.65 | 26.2% | 46.4 |
| 2595 | 9 | 60 | 24% | 79% | \$192,821,192.46 | 7.79% | 0.29 | 0.60 | 0.57 | 27.0% | 46.4 |
| 1263 | 8 | 60 | 24% | 78% | \$185,715,315.68 | 7.56% | 0.29 | 0.60 | 0.60 | 26.4% | 46.4 |

Below is a graph of the equity curve for the strategy with the highest MAR.



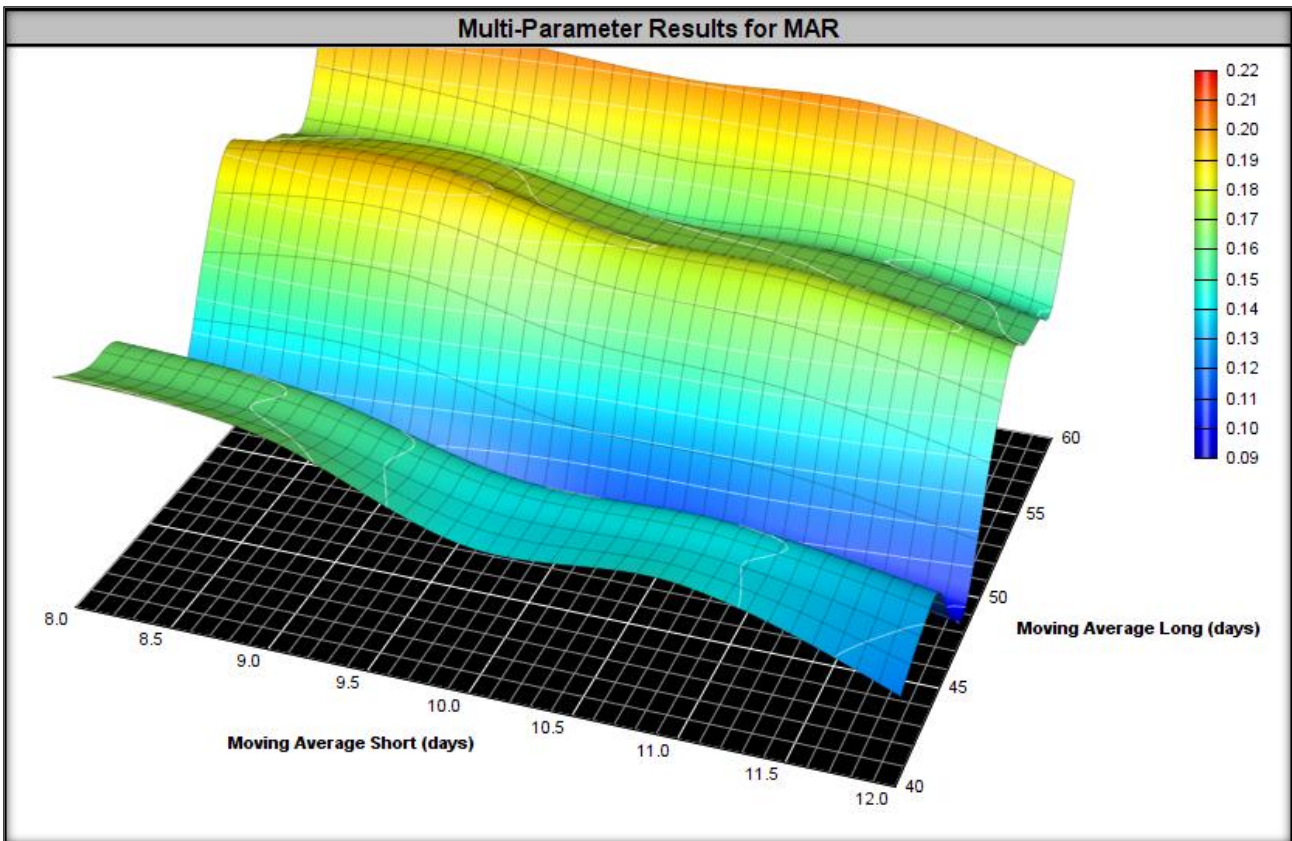
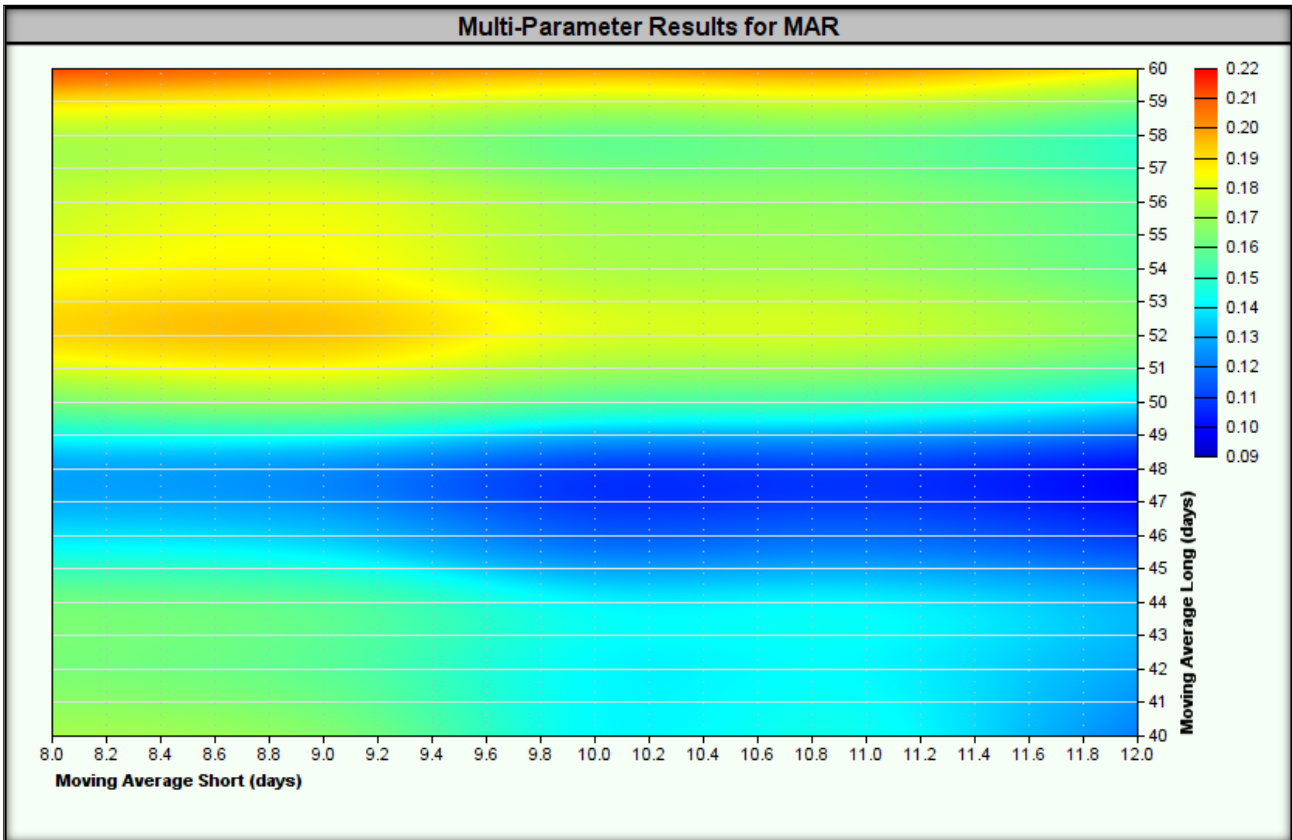
For all combinations of tested parameter ranges, **the highest drawdown was 41.3%**.

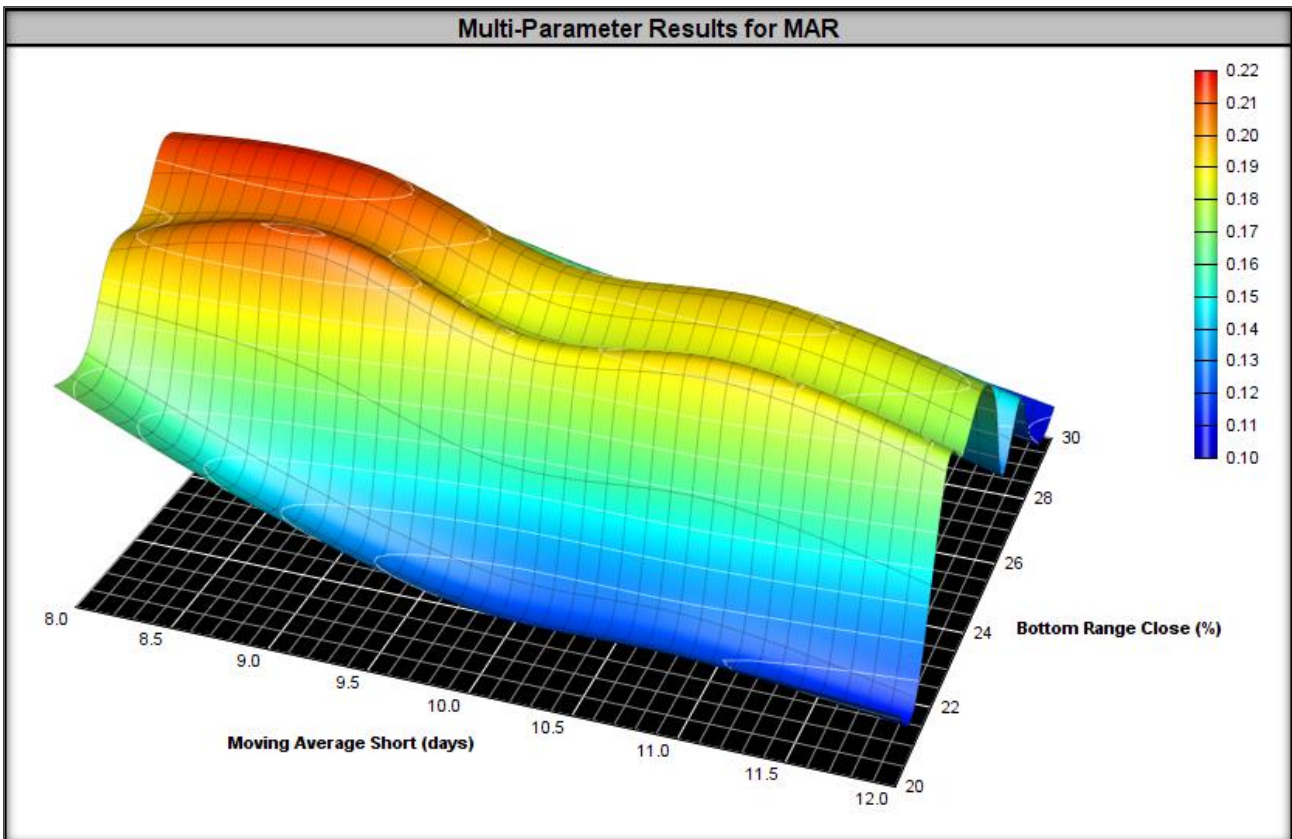
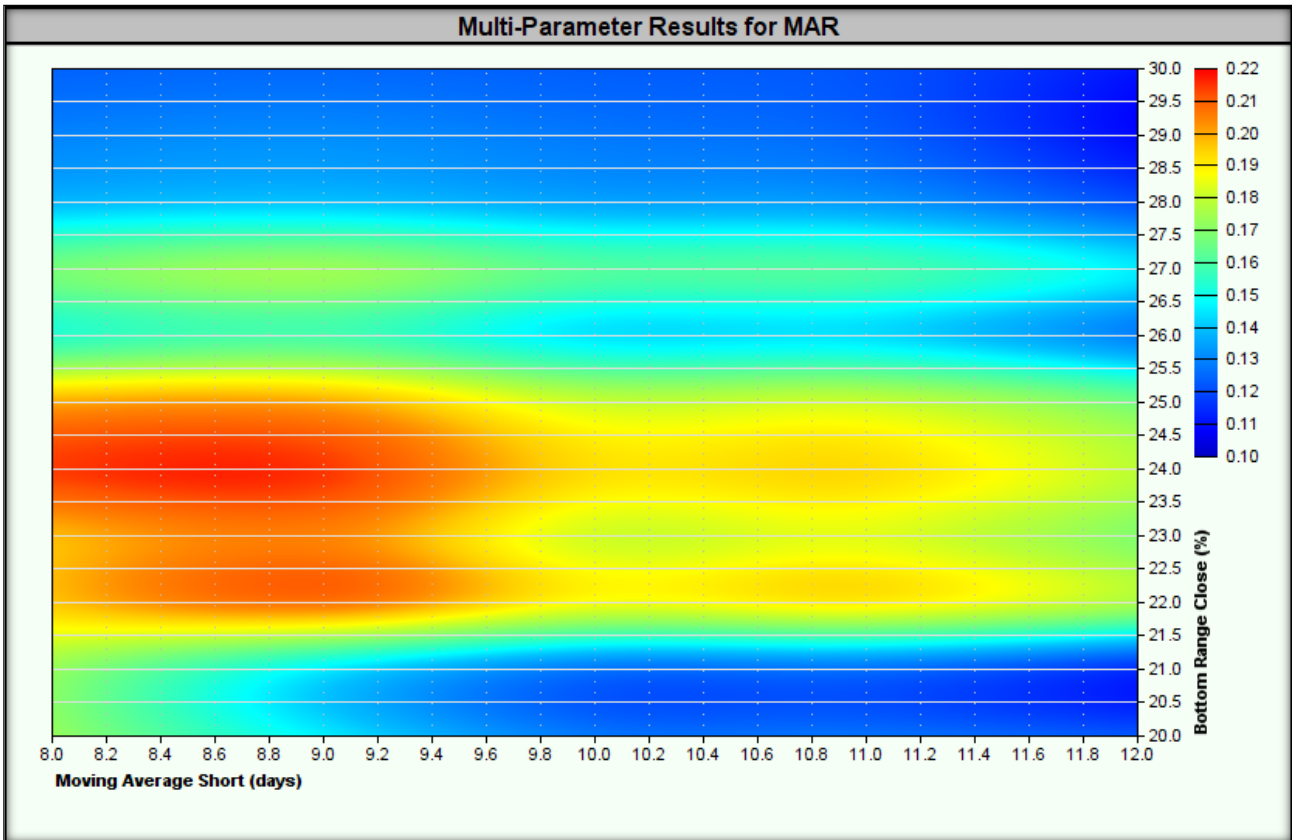
| Test | Moving Average Short (days) | Moving Average Long (days) | Bottom Range Close (%) | Top Range Close (%) | End Balance | CAGR% | MAR | Sharpe | Ann. Sharpe | Max TE DD | Longest DD |
|------|-----------------------------|----------------------------|------------------------|---------------------|------------------|-------|------|--------|-------------|-----------|------------|
| 6030 | 12 | 50 | 29% | 71% | \$83,867,885.20 | 2.92% | 0.07 | 0.26 | 0.18 | 41.3% | 74.1 |
| 6041 | 12 | 50 | 30% | 71% | \$80,413,272.69 | 2.68% | 0.06 | 0.25 | 0.17 | 41.2% | 74.5 |
| 6029 | 12 | 50 | 29% | 70% | \$82,370,002.82 | 2.81% | 0.07 | 0.26 | 0.19 | 40.3% | 72.2 |
| 3158 | 10 | 48 | 21% | 70% | \$77,930,464.40 | 2.50% | 0.06 | 0.26 | 0.23 | 39.6% | 117.7 |
| 6040 | 12 | 50 | 30% | 70% | \$79,019,931.38 | 2.58% | 0.07 | 0.24 | 0.18 | 39.6% | 72.3 |
| 3048 | 10 | 46 | 22% | 70% | \$104,677,405.67 | 4.19% | 0.11 | 0.39 | 0.31 | 39.3% | 117.7 |
| 6150 | 12 | 52 | 29% | 70% | \$96,146,727.38 | 3.70% | 0.09 | 0.31 | 0.22 | 39.2% | 70.7 |
| 6151 | 12 | 52 | 29% | 71% | \$97,487,777.57 | 3.78% | 0.10 | 0.31 | 0.21 | 39.2% | 72.3 |
| 6514 | 12 | 58 | 29% | 71% | \$87,751,681.26 | 3.17% | 0.08 | 0.27 | 0.19 | 39.1% | 72.2 |

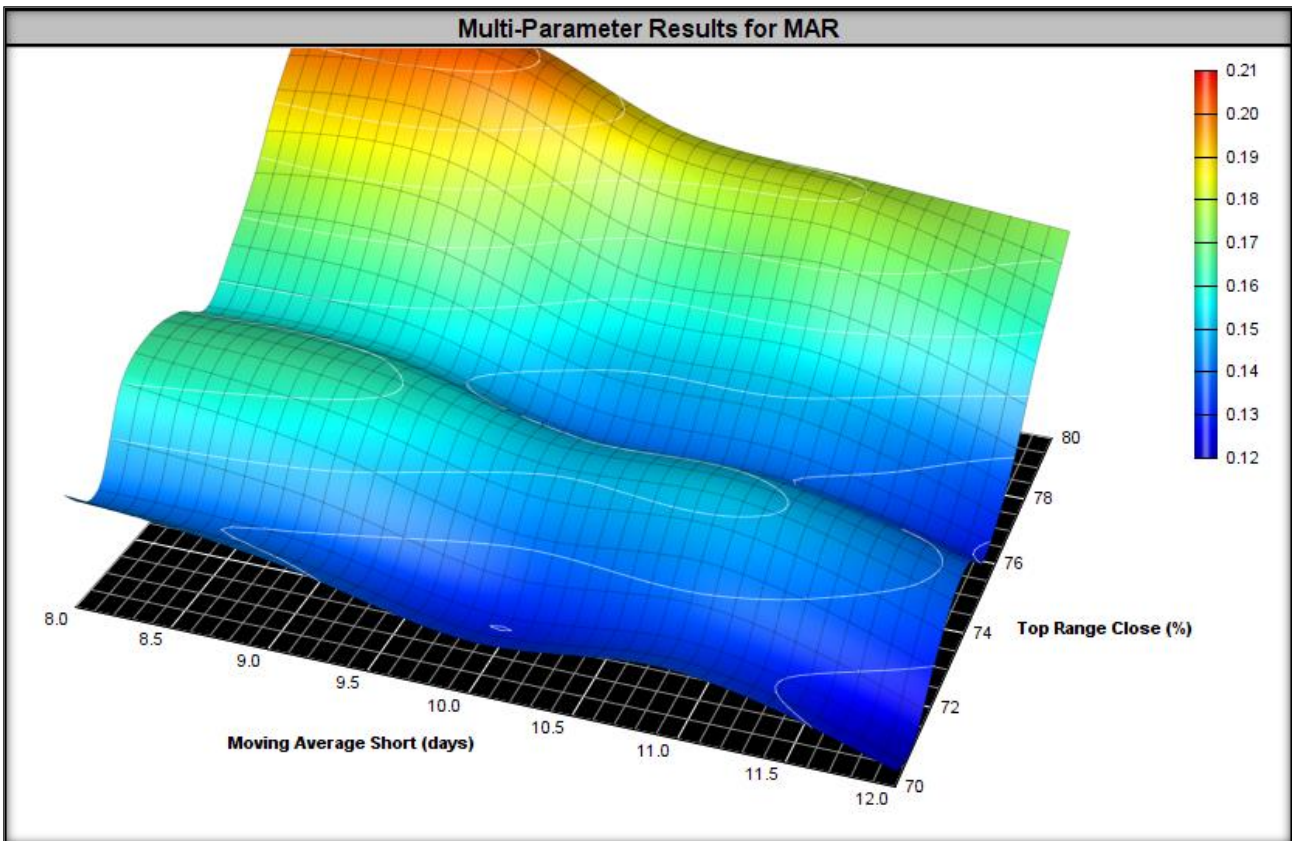
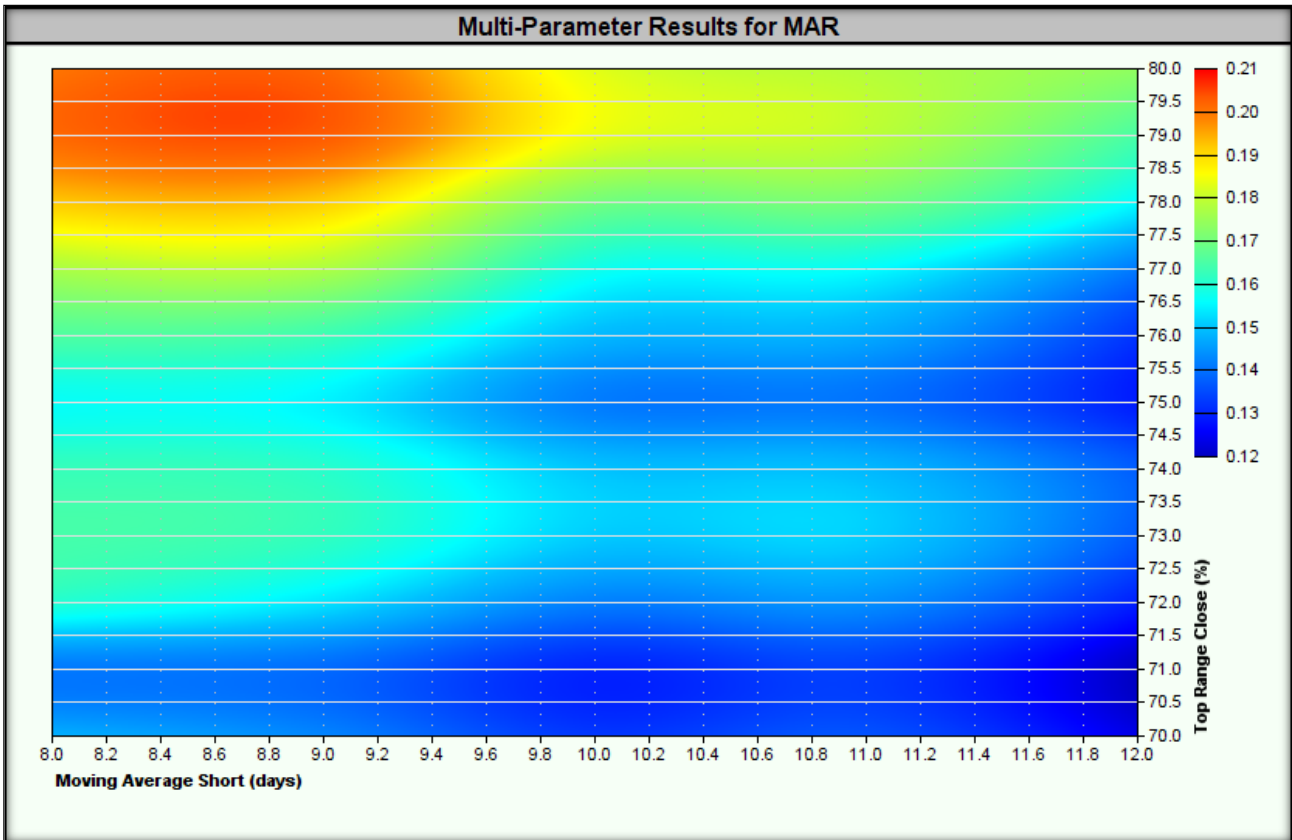
In summary, the strategy **passed the stability test** in a wide range of optimized parameters on in-sample data because:

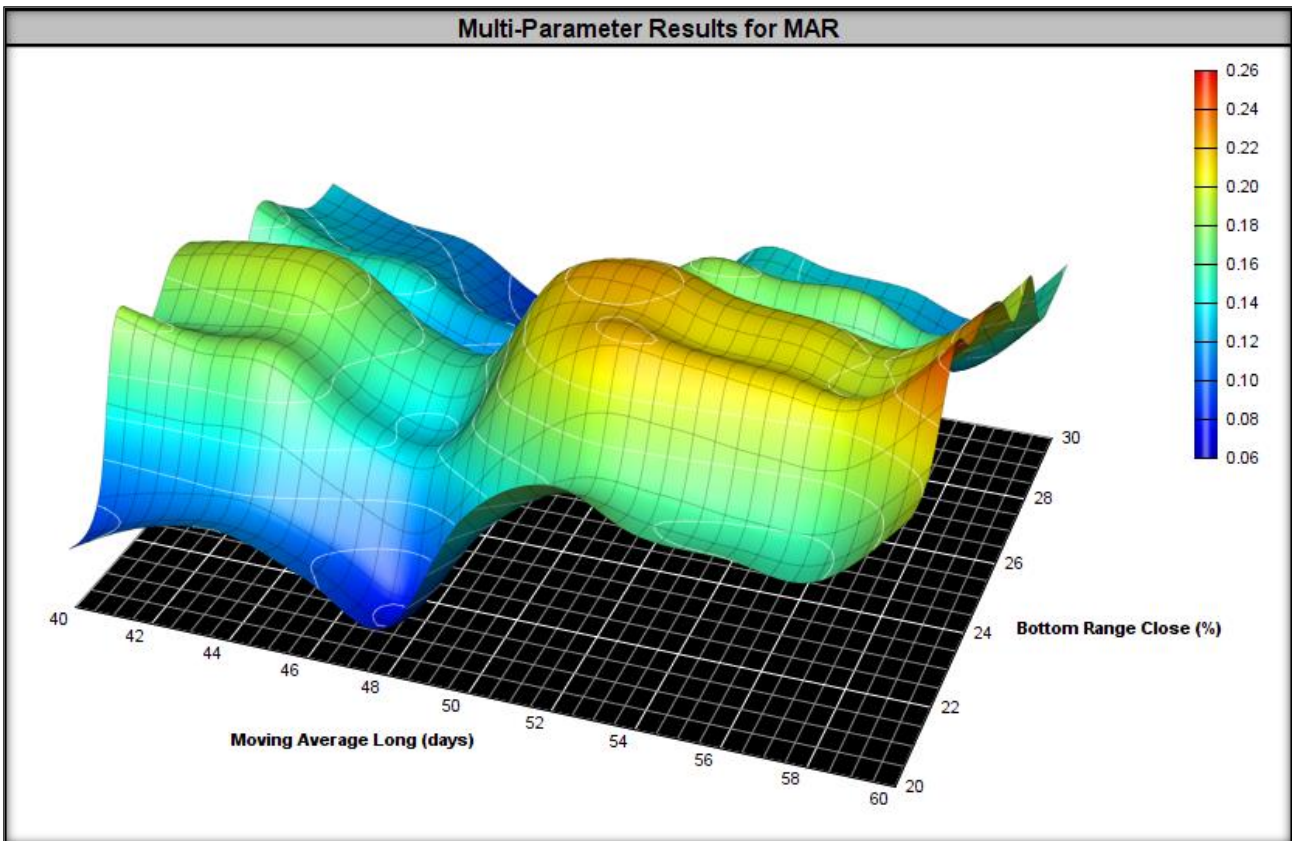
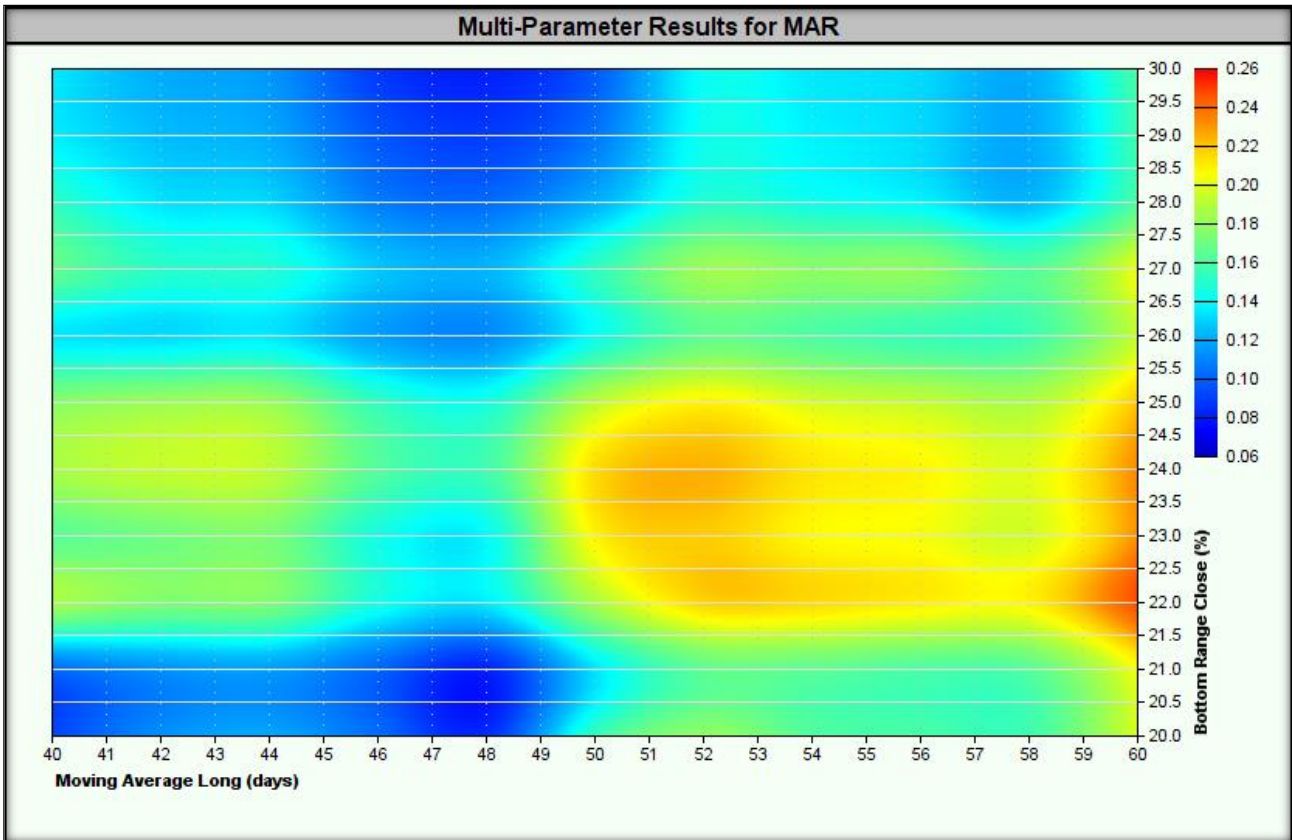
- **MAR value** – which indicates the stability of the strategy in various market conditions.
- **The maximum drawdown did not exceed 250% of the drawdown value** for the result with the highest MAR (**41.3% vs. 25.8%**) – which means an acceptable risk of deep capital drawdowns.

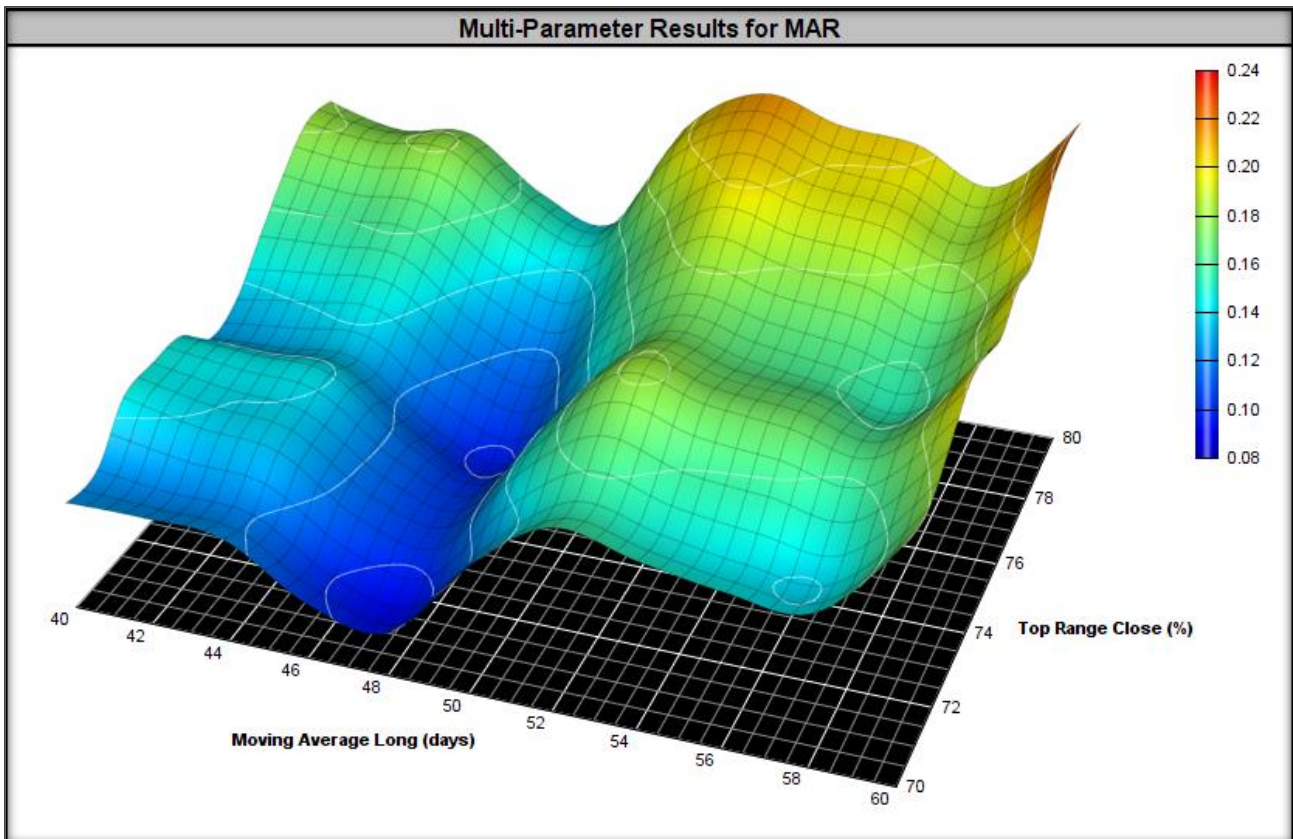
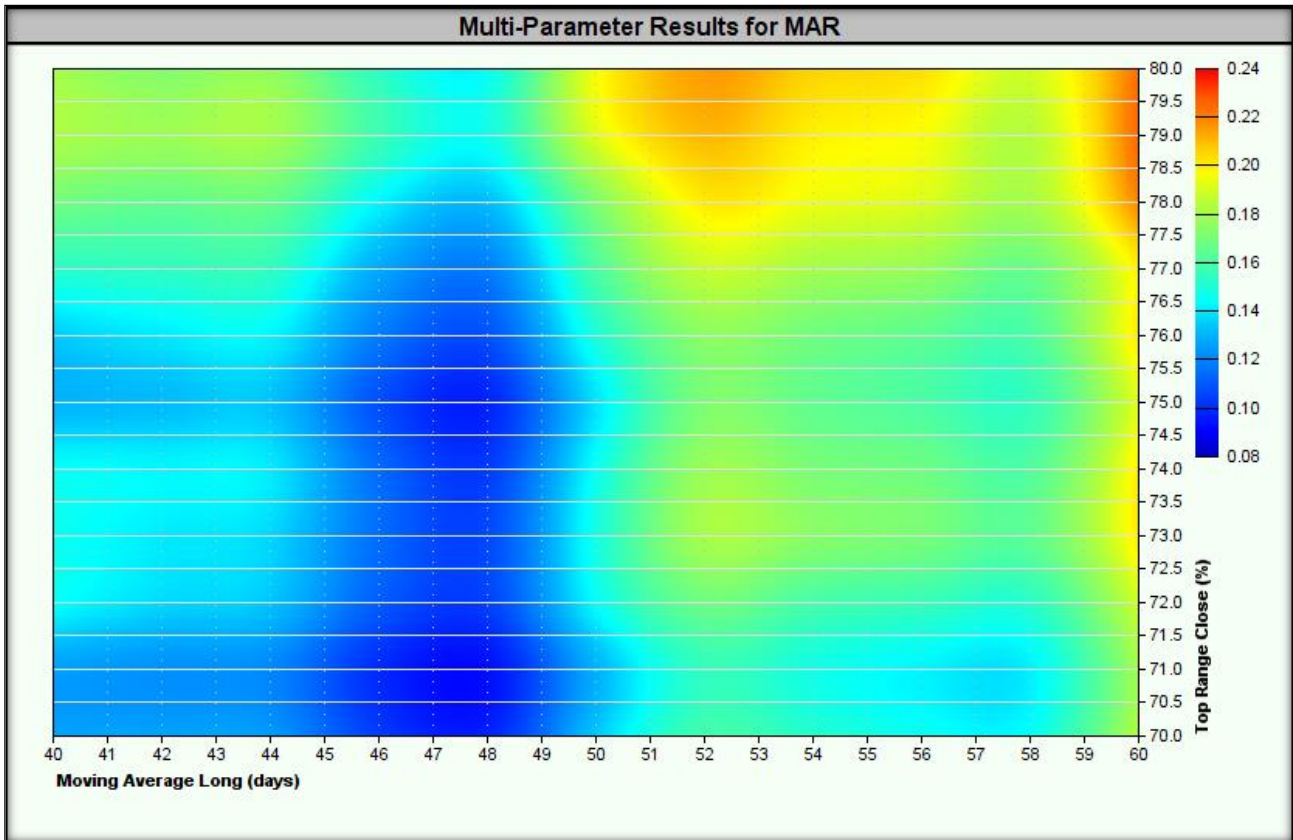
Heatmaps for the tested ranges are presented below.

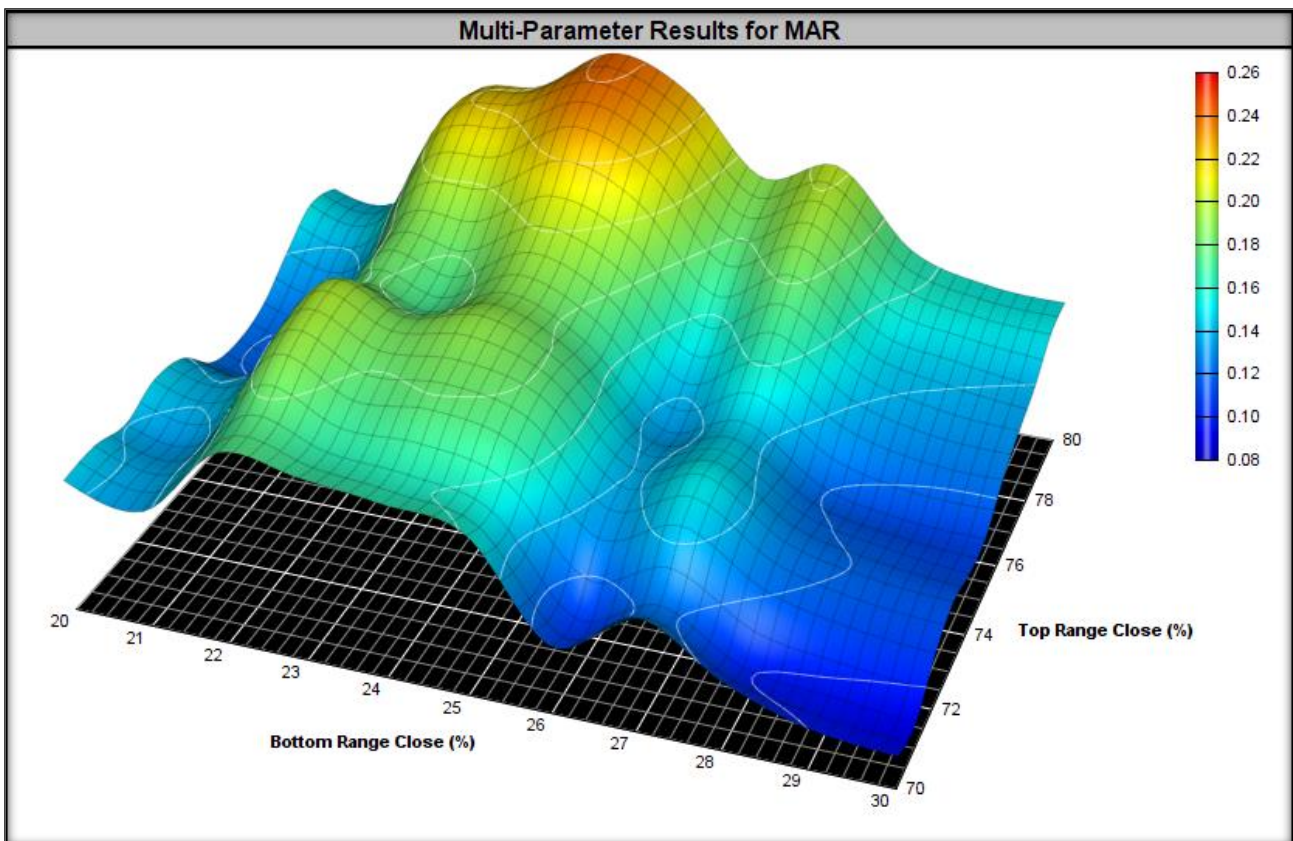
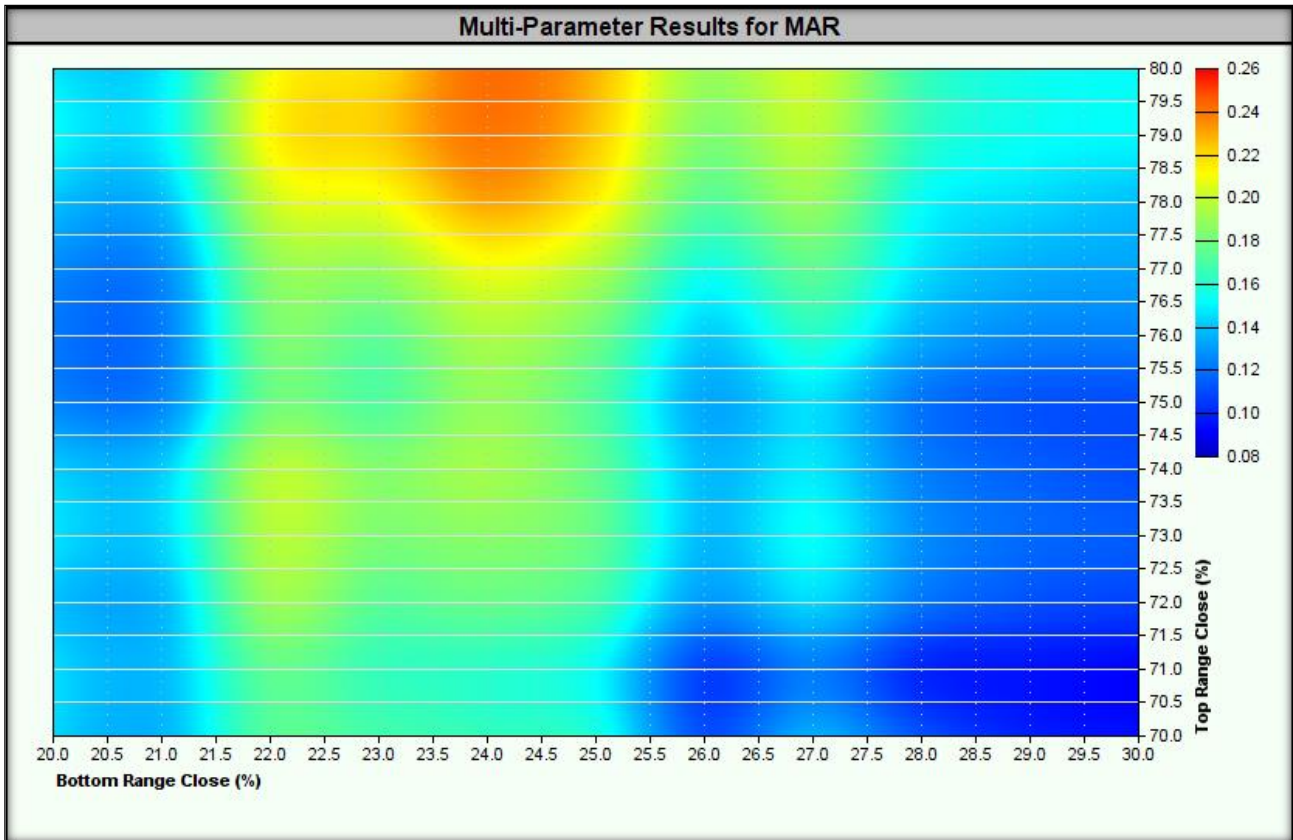


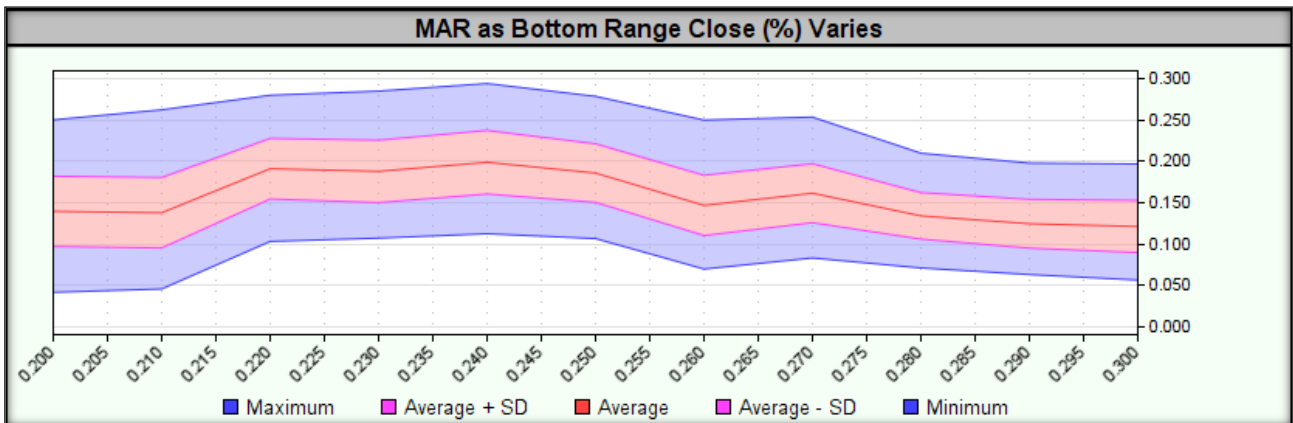
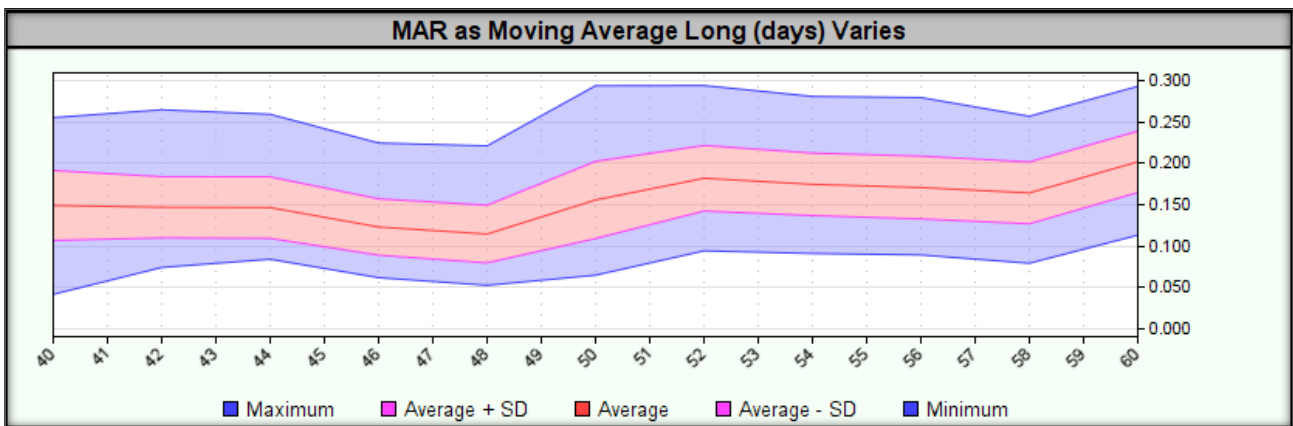
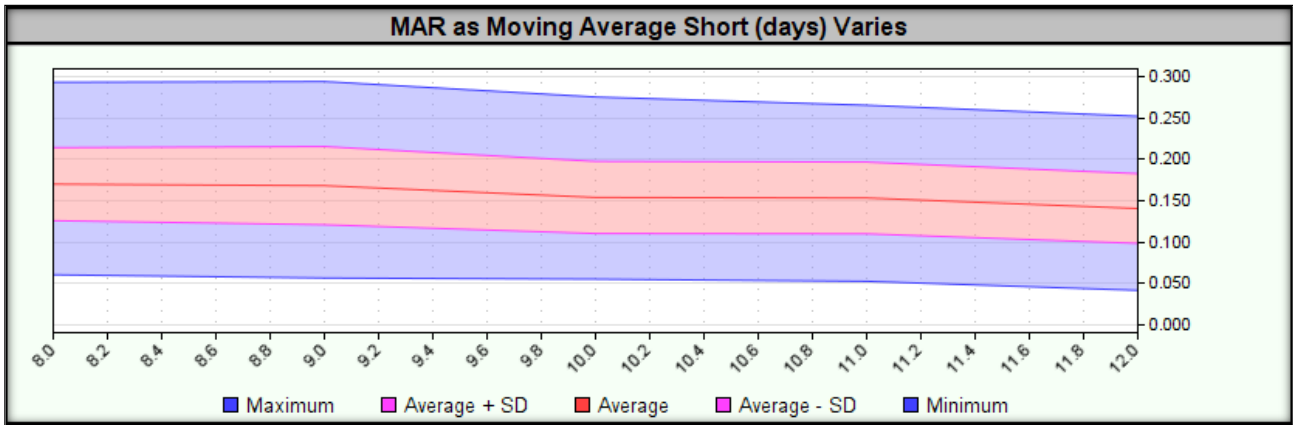


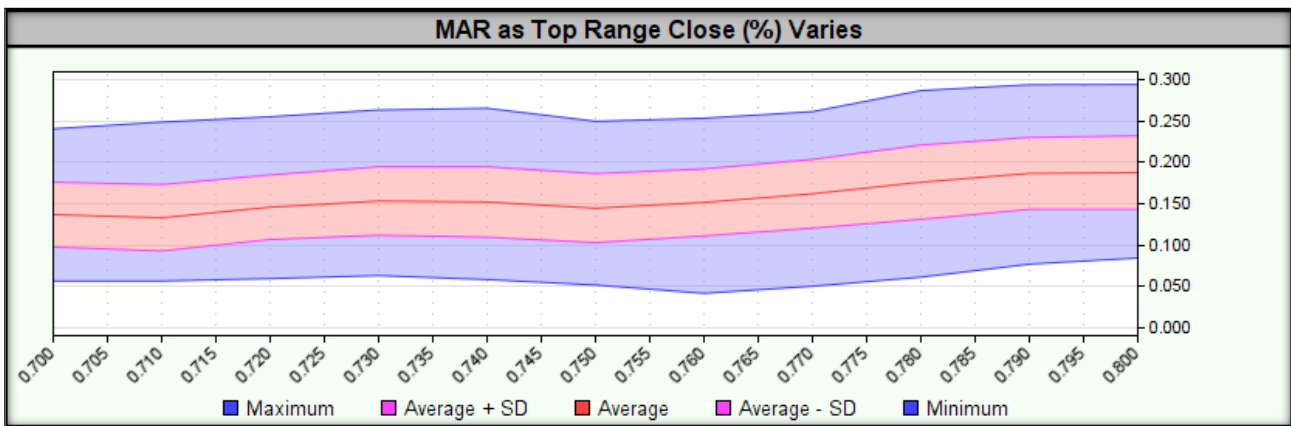












After passing the stability tests on **the in-sample data**, it is time to perform the same on **the out-of-sample data**. For this purpose, we use **the same range of parameters** as on the in-sample data:

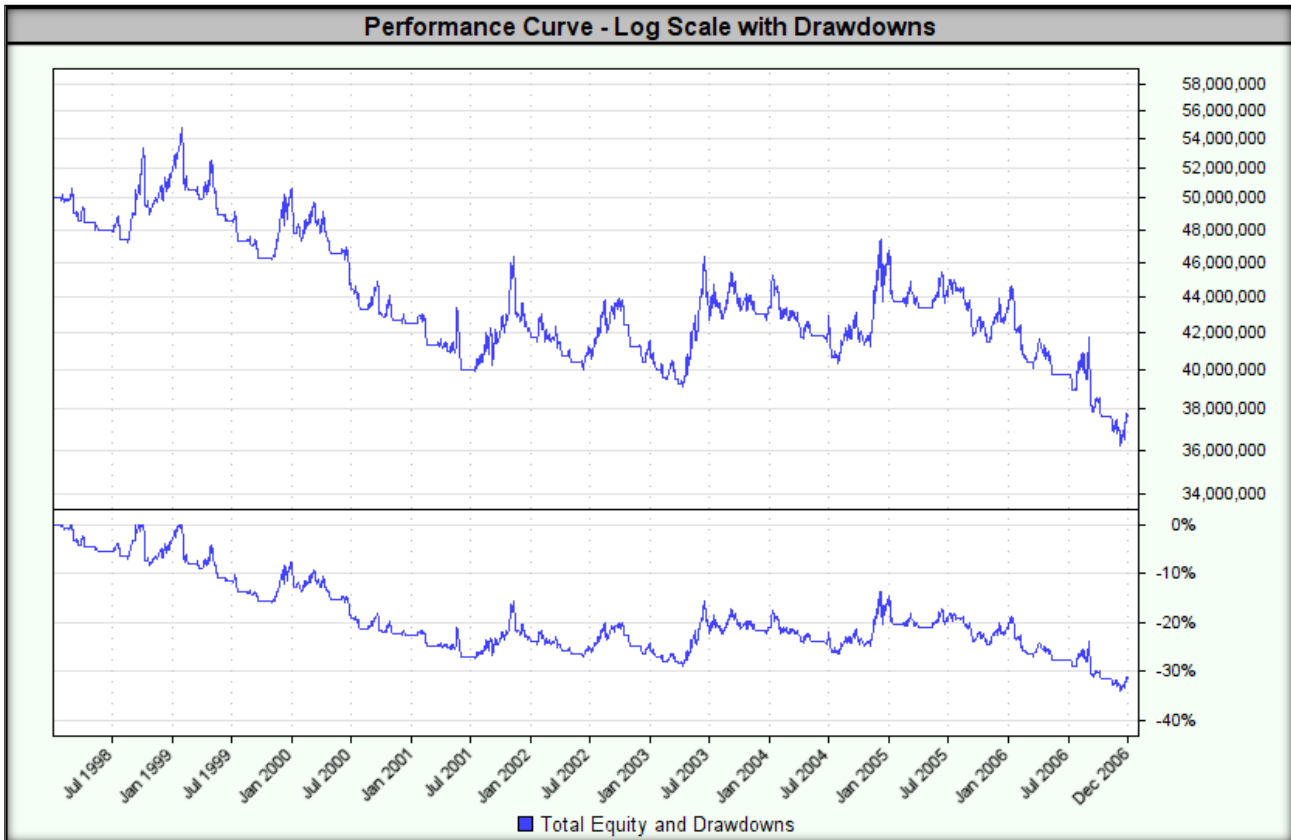
- **Short Moving Average (SMA) Lengths: Range 8-12 days (step: 1);**
- **Long Moving Average (SMA) Lengths: 40-60 day range (step: 2);**
- **Formation candle:**
 - **Lower closing range of the first candle: range 20%-30% (step: 1 pp.);**
 - **Upper closing range of the second candle: range 20%-30% (step: 1 pp.).**

The lowest MAR value of **-0.09** was achieved for the following parameters:

- **Short Moving Average (SMA) Lengths: 10;**
- **Long Moving Average (SMA) Lengths: 42;**
- **Formation candle:**
 - **Lower closing range of the first candle: 20%;**
 - **Upper closing range of the second candle: 20%.**

| Test | Moving Average Short (days) | Moving Average Long (days) | Bottom Range Close (%) | Top Range Close (%) | End Balance | CAGR% | MAR | Sharpe | Ann. Sharpe | Max TE DD | Longest DD |
|------|-----------------------------|----------------------------|------------------------|---------------------|-----------------|--------|-------|--------|-------------|-----------|------------|
| 2794 | 10 | 42 | 20% | 80% | \$37,596,765.56 | -3.12% | -0.09 | -0.24 | -0.42 | 34.0% | 95.0 |
| 2787 | 10 | 42 | 20% | 73% | \$36,618,579.28 | -3.40% | -0.09 | -0.28 | -0.44 | 37.2% | 95.0 |
| 2666 | 10 | 40 | 20% | 73% | \$37,139,133.73 | -3.25% | -0.09 | -0.26 | -0.42 | 36.3% | 95.0 |
| 2788 | 10 | 42 | 20% | 74% | \$37,382,829.52 | -3.18% | -0.09 | -0.26 | -0.40 | 35.7% | 91.9 |
| 2793 | 10 | 42 | 20% | 79% | \$37,541,525.51 | -3.14% | -0.09 | -0.25 | -0.43 | 35.7% | 95.0 |
| 2673 | 10 | 40 | 20% | 80% | \$38,426,684.57 | -2.89% | -0.09 | -0.22 | -0.39 | 32.9% | 95.0 |
| 2667 | 10 | 40 | 20% | 74% | \$37,907,343.07 | -3.03% | -0.09 | -0.24 | -0.39 | 34.8% | 91.9 |
| 2672 | 10 | 40 | 20% | 79% | \$38,046,571.77 | -2.99% | -0.09 | -0.24 | -0.41 | 34.8% | 95.0 |
| 2789 | 10 | 42 | 20% | 75% | \$38,278,904.22 | -2.93% | -0.09 | -0.24 | -0.36 | 34.2% | 91.9 |
| 3029 | 10 | 46 | 20% | 73% | \$39,451,167.92 | -2.60% | -0.08 | -0.19 | -0.33 | 30.8% | 95.0 |

Below is a graph of the equity curve for **the strategy with the lowest MAR**.



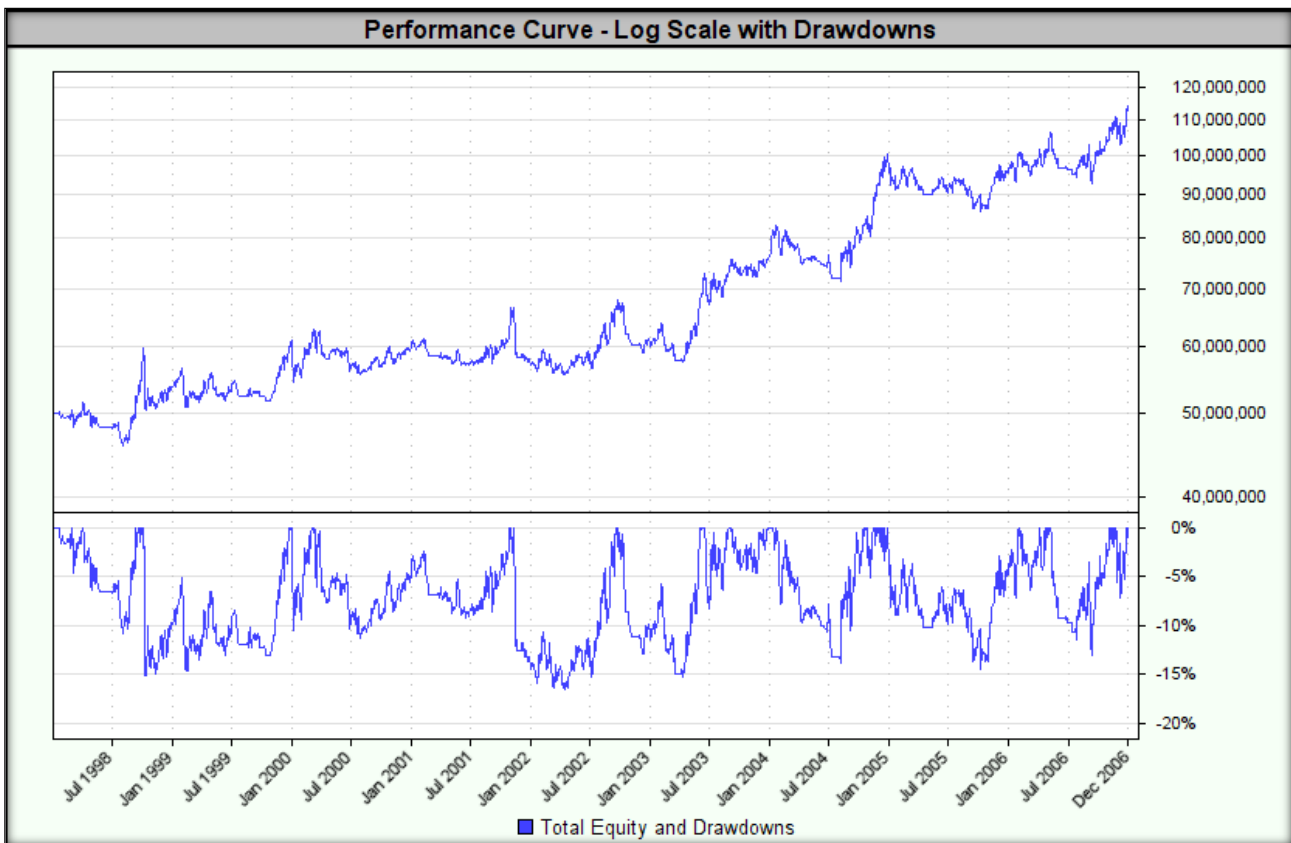
The highest MAR value of 0.58 was achieved for the following parameters:

- Short Moving Average (SMA) Lengths: 8;
- Long Moving Average (SMA) Lengths: 60;
- Formation candle:
 - Lower closing range of the first candle: 30%;
 - Upper closing range of the second candle: 23%.

The highest MAR value was accompanied by a drawdown of 16.4%.

| Test | Moving Average Short (days) | Moving Average Long (days) | Bottom Range Close (%) | Top Range Close (%) | End Balance | CAGR% | MAR | Sharpe | Ann. Sharpe | Max TE DD | Longest DD |
|------|-----------------------------|----------------------------|------------------------|---------------------|------------------|-------|------|--------|-------------|-----------|------------|
| 1328 | 8 | 60 | 30% | 77% | \$112,938,700.41 | 9.49% | 0.58 | 0.69 | 0.87 | 16.4% | 19.6 |
| 1326 | 8 | 60 | 30% | 75% | \$112,011,669.82 | 9.39% | 0.57 | 0.69 | 0.89 | 16.4% | 19.7 |
| 1329 | 8 | 60 | 30% | 78% | \$110,991,806.20 | 9.27% | 0.56 | 0.67 | 0.84 | 16.5% | 19.6 |
| 1327 | 8 | 60 | 30% | 76% | \$109,596,749.31 | 9.12% | 0.55 | 0.67 | 0.85 | 16.4% | 19.7 |
| 1323 | 8 | 60 | 30% | 72% | \$107,928,912.89 | 8.93% | 0.51 | 0.64 | 0.77 | 17.4% | 19.7 |
| 1330 | 8 | 60 | 30% | 79% | \$104,692,726.43 | 8.57% | 0.51 | 0.63 | 0.76 | 16.7% | 36.9 |
| 1325 | 8 | 60 | 30% | 74% | \$106,982,076.16 | 8.83% | 0.51 | 0.65 | 0.85 | 17.4% | 19.7 |
| 1322 | 8 | 60 | 30% | 71% | \$105,324,419.83 | 8.64% | 0.50 | 0.62 | 0.75 | 17.4% | 19.7 |
| 1321 | 8 | 60 | 30% | 70% | \$104,081,690.27 | 8.50% | 0.49 | 0.61 | 0.72 | 17.5% | 19.7 |
| 1207 | 8 | 58 | 30% | 77% | \$97,045,358.20 | 7.65% | 0.48 | 0.58 | 0.64 | 15.9% | 22.2 |

Below is a graph of the equity curve for the strategy with the highest MAR.



For all combinations of tested parameter ranges, **the highest drawdown was 37.6%**.

| Test | Moving Average Short (days) | Moving Average Long (days) | Bottom Range Close (%) | Top Range Close (%) | End Balance | CAGR% | MAR | Sharpe | Ann. Sharpe | Max ... | Longest DD |
|------|-----------------------------|----------------------------|------------------------|---------------------|-----------------|--------|-------|--------|-------------|---------|------------|
| 6029 | 12 | 50 | 29% | 70% | \$61,186,449.37 | 2.27% | 0.06 | 0.23 | 0.24 | 37.6% | 85.6 |
| 6007 | 12 | 50 | 27% | 70% | \$59,980,744.14 | 2.04% | 0.05 | 0.21 | 0.21 | 37.5% | 98.7 |
| 683 | 8 | 50 | 27% | 70% | \$61,656,268.67 | 2.36% | 0.06 | 0.23 | 0.23 | 37.5% | 97.0 |
| 6040 | 12 | 50 | 30% | 70% | \$64,782,450.02 | 2.92% | 0.08 | 0.27 | 0.28 | 37.4% | 74.0 |
| 2787 | 10 | 42 | 20% | 73% | \$36,618,579.28 | -3.40% | -0.09 | -0.28 | -0.44 | 37.2% | 95.0 |
| 6018 | 12 | 50 | 28% | 70% | \$64,175,599.35 | 2.81% | 0.08 | 0.26 | 0.30 | 36.9% | 85.2 |
| 694 | 8 | 50 | 28% | 70% | \$65,958,709.26 | 3.13% | 0.08 | 0.29 | 0.31 | 36.8% | 74.7 |
| 705 | 8 | 50 | 29% | 70% | \$64,227,977.74 | 2.82% | 0.08 | 0.27 | 0.28 | 36.8% | 85.4 |
| 2666 | 10 | 40 | 20% | 73% | \$37,139,133.73 | -3.25% | -0.09 | -0.26 | -0.42 | 36.3% | 95.0 |
| 3345 | 10 | 50 | 27% | 70% | \$58,811,847.16 | 1.82% | 0.05 | 0.20 | 0.19 | 36.2% | 80.1 |

In summary, the strategy failed the stability test over a wide range of optimized parameters because:

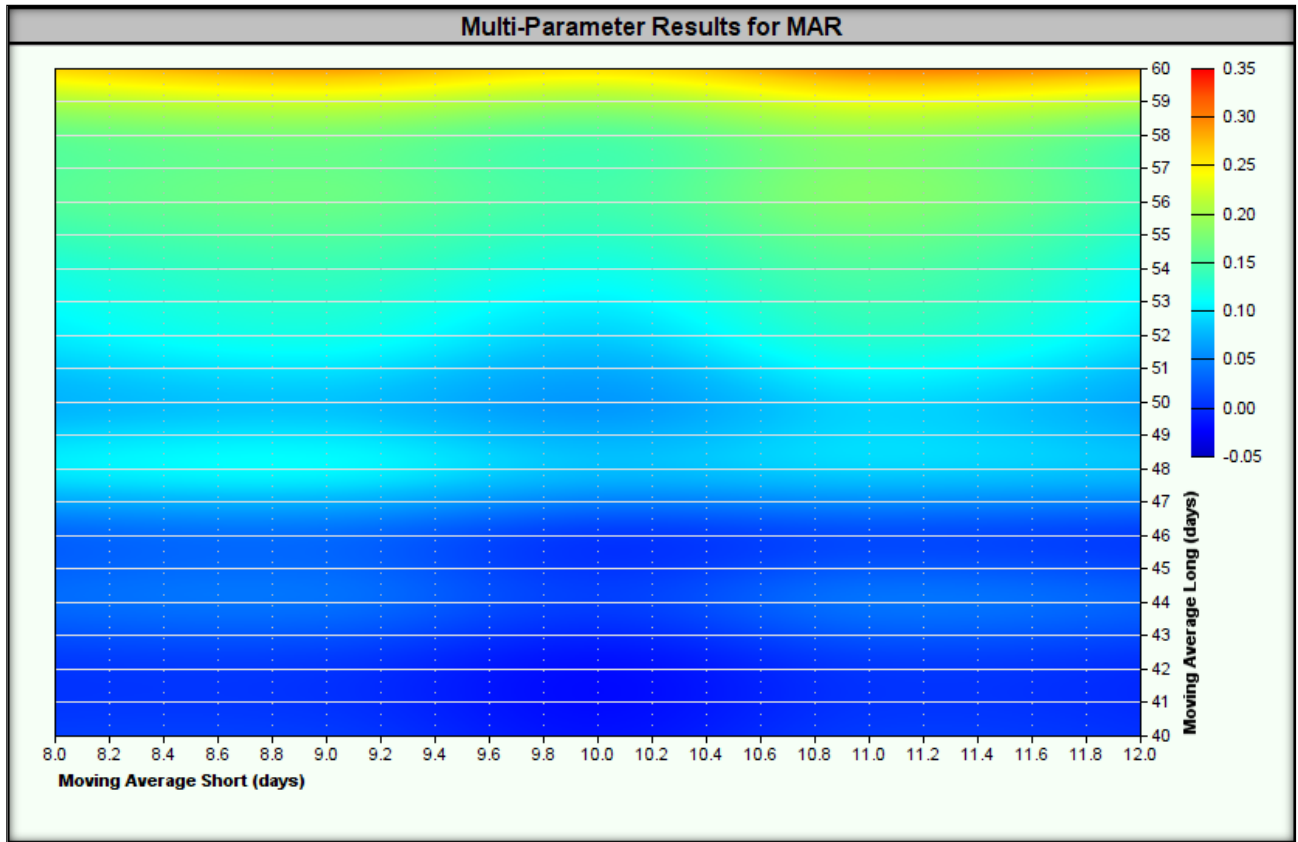
- **MAR value** – which indicates low stability of the strategy in various market conditions.

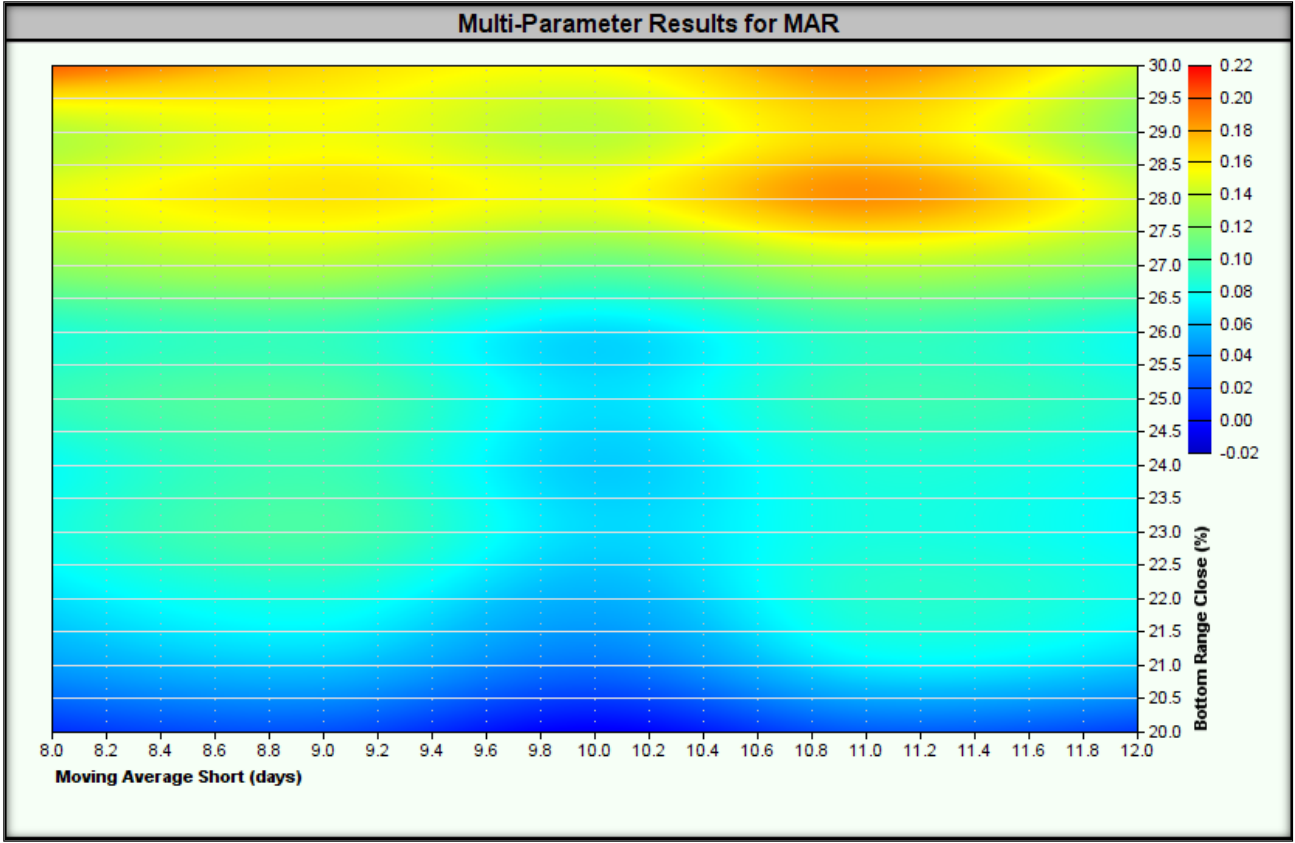
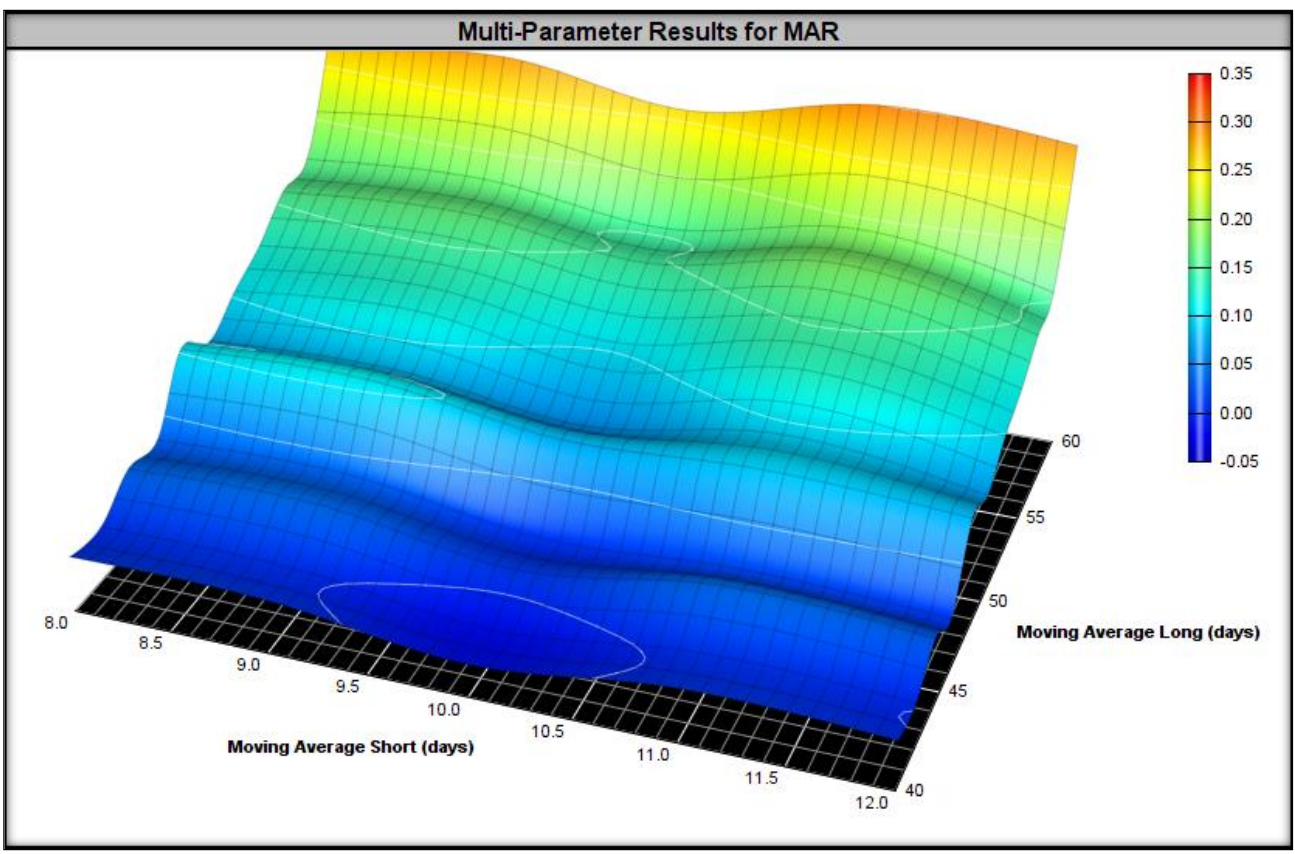
Therefore, **further testing of the strategy on these ranges is not justified**, because its use in real transactions is **highly doubtful**. Nevertheless, based on the results obtained (**heatmaps for tested ranges**) and the behavior of the strategy, we can create another version, in which we will include:

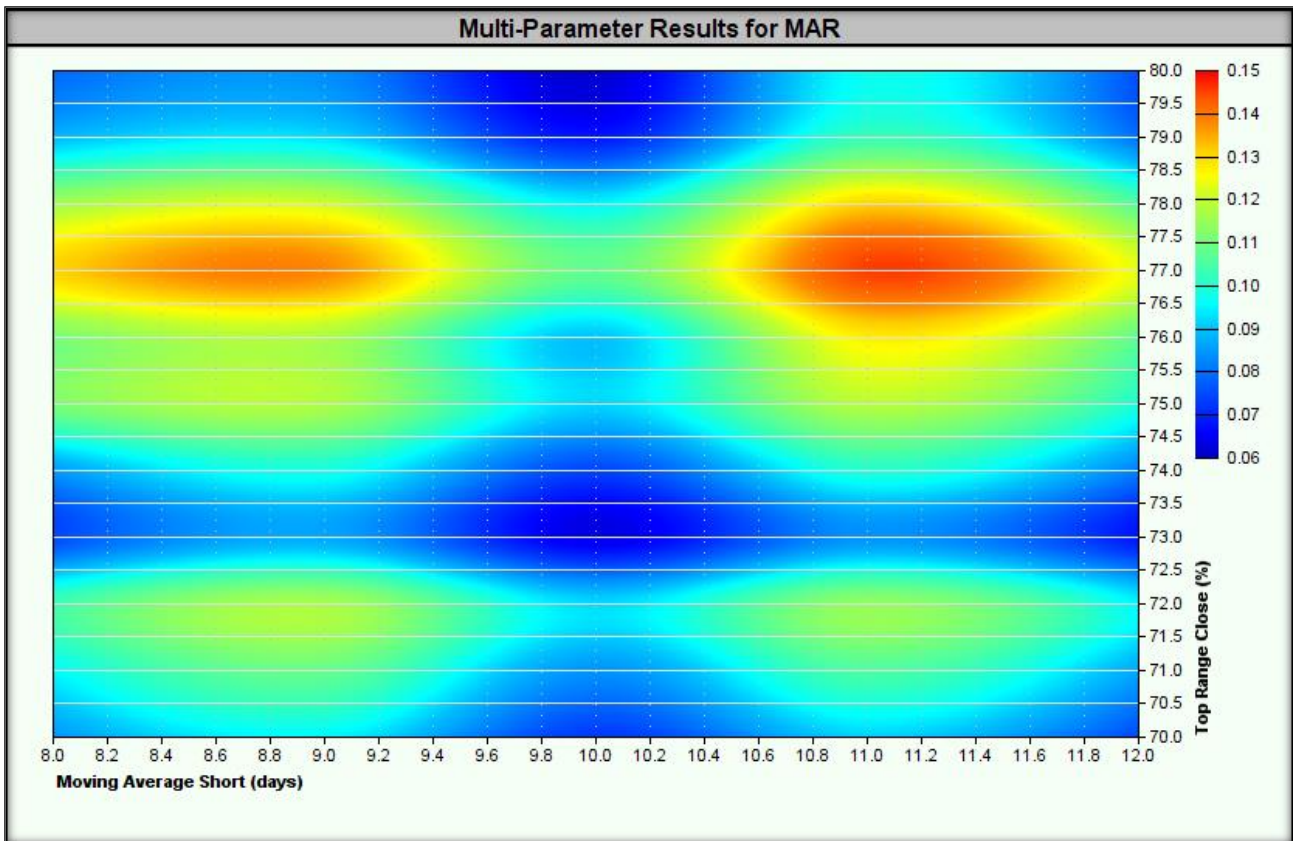
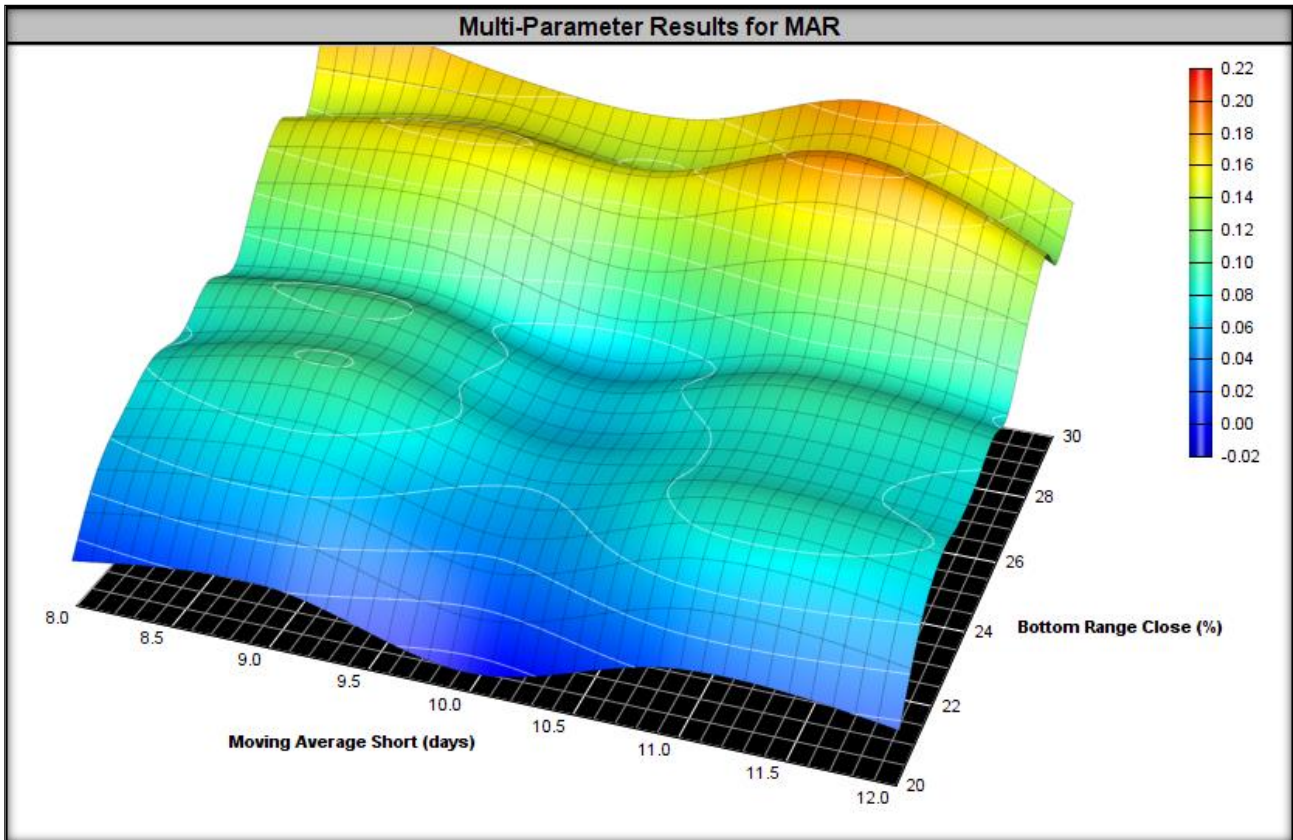
- **One common parameter for the lower and upper closing range of the candle** – this will reduce the number of parameters from 4 to 3, which should improve the stability of the strategy.
- **Long Moving Average (SMA) Optimization** – Heatmaps indicate that better results can be achieved when the long SMA is above 60.
- **Adding the remaining futures contracts to the instrument portfolio** – increasing the portfolio of tested instruments may improve the stability of the strategy.

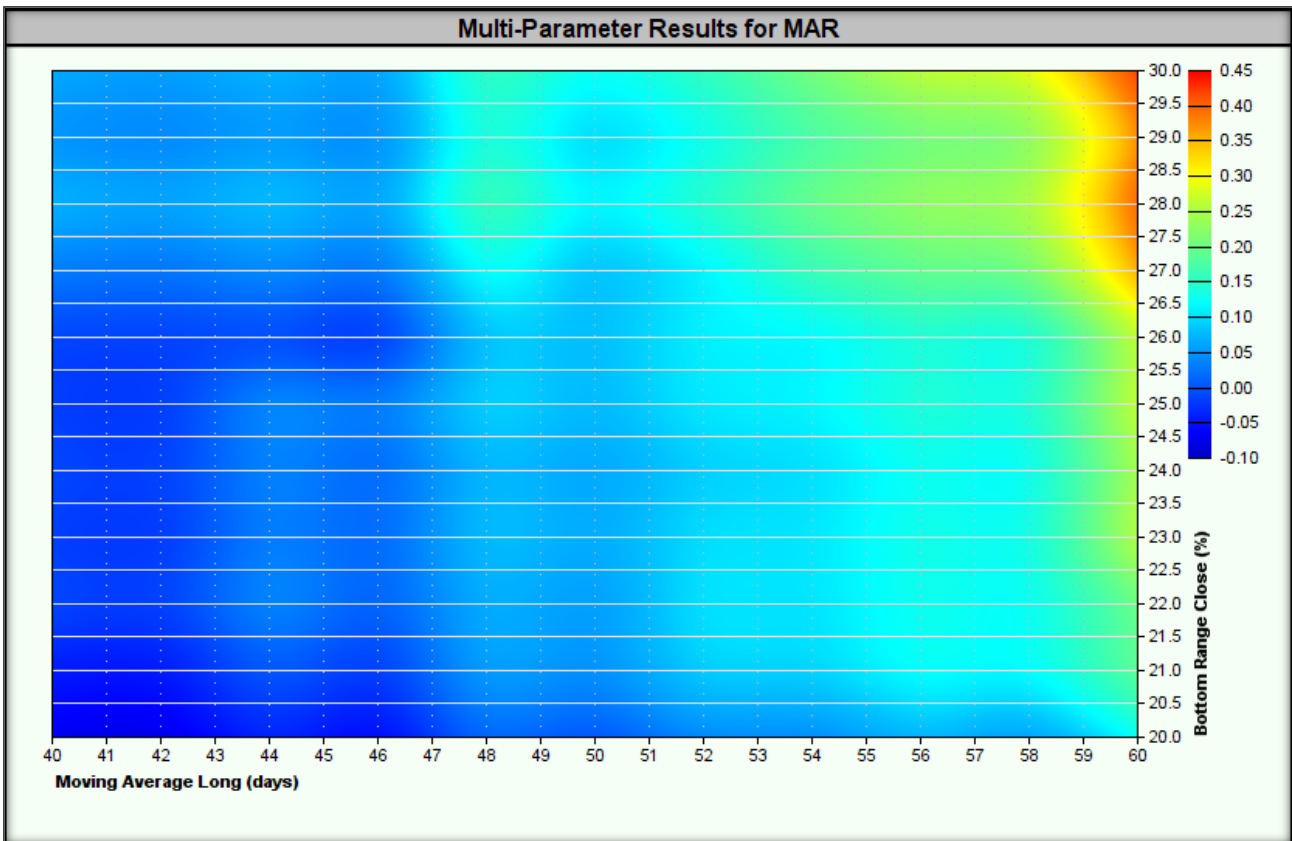
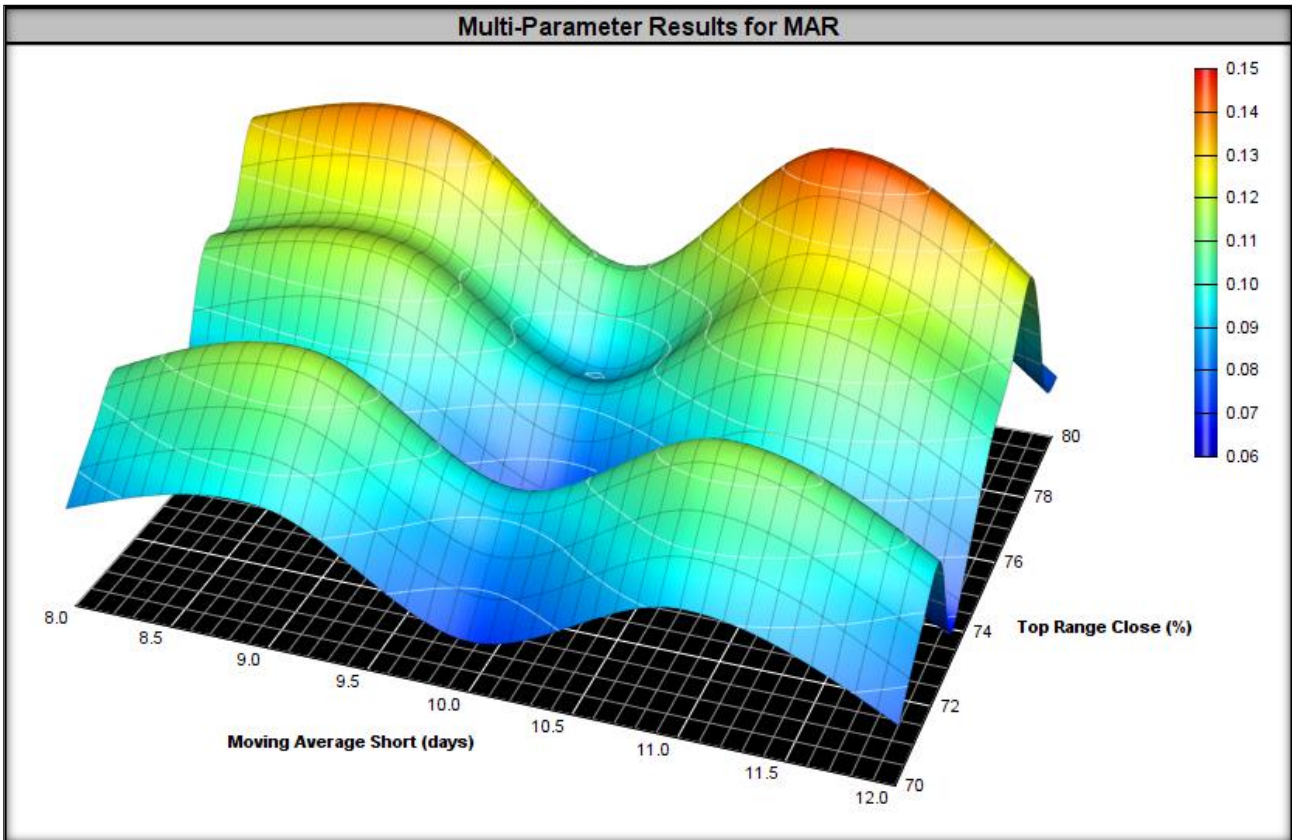


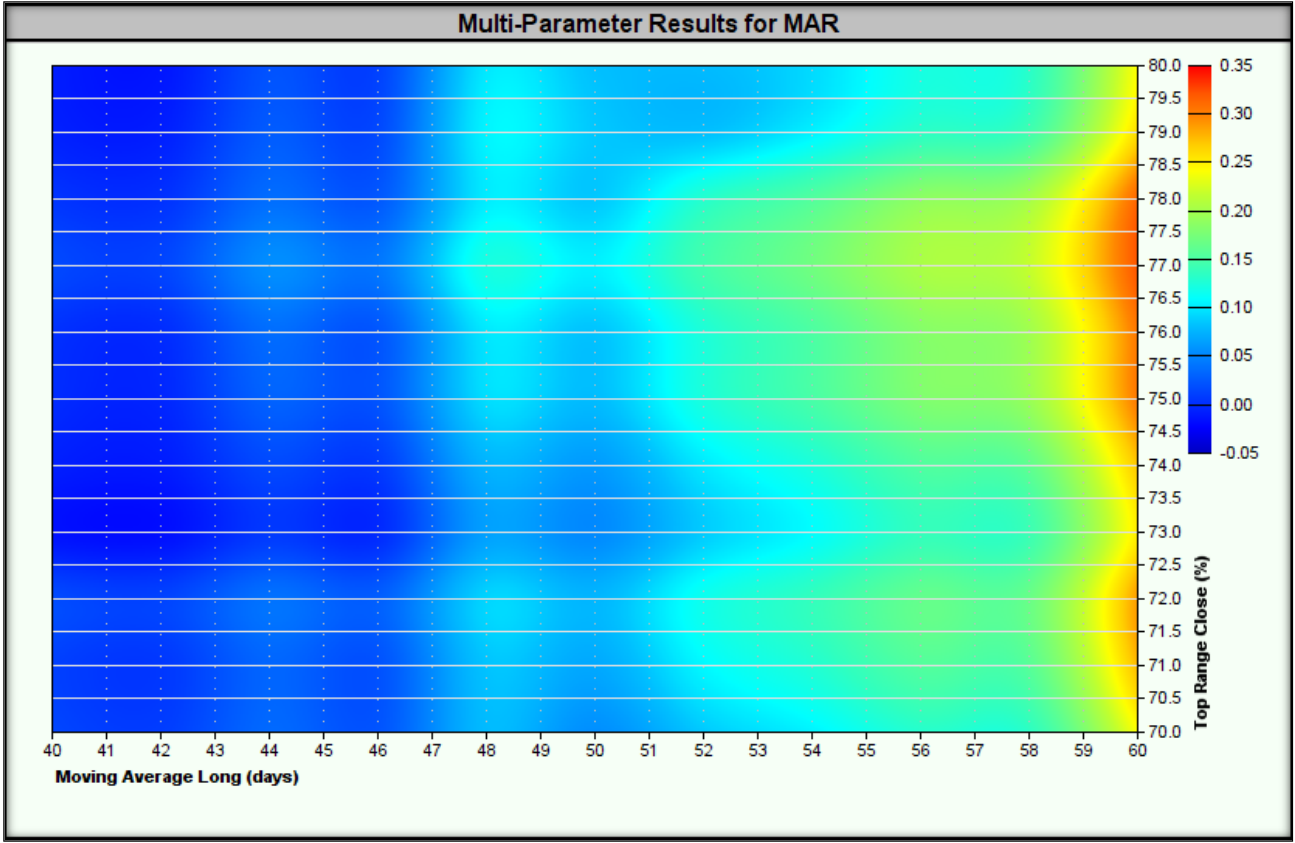
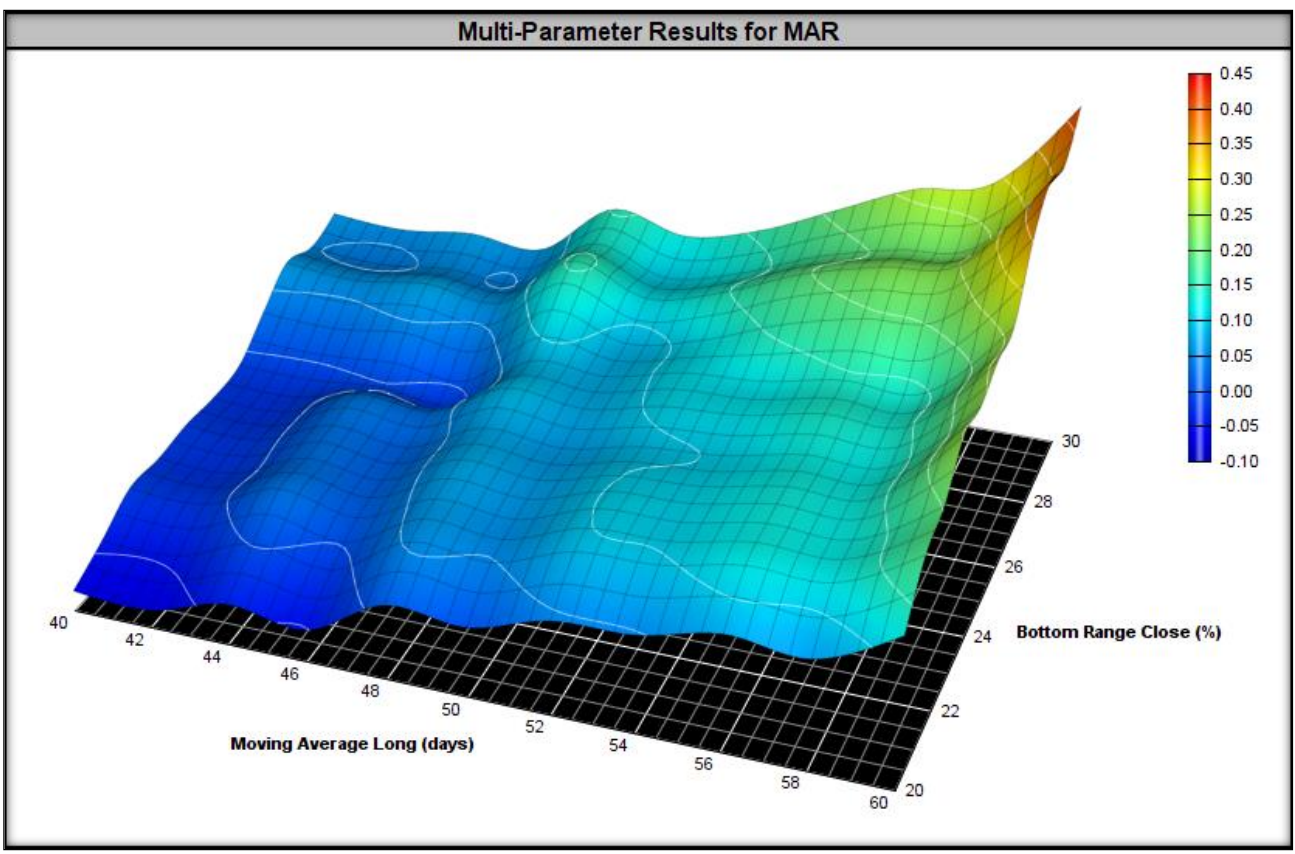
Heatmaps for the tested ranges are presented below.

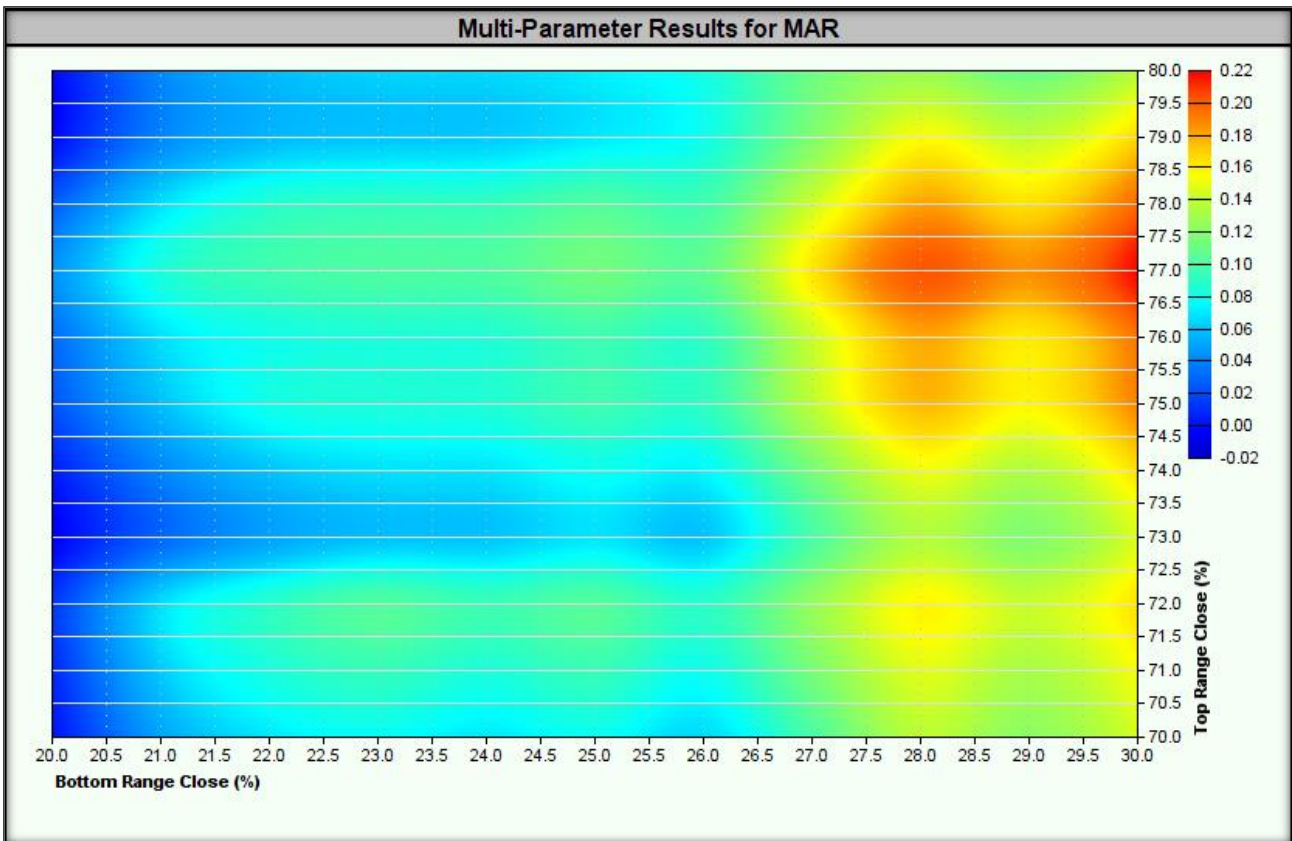
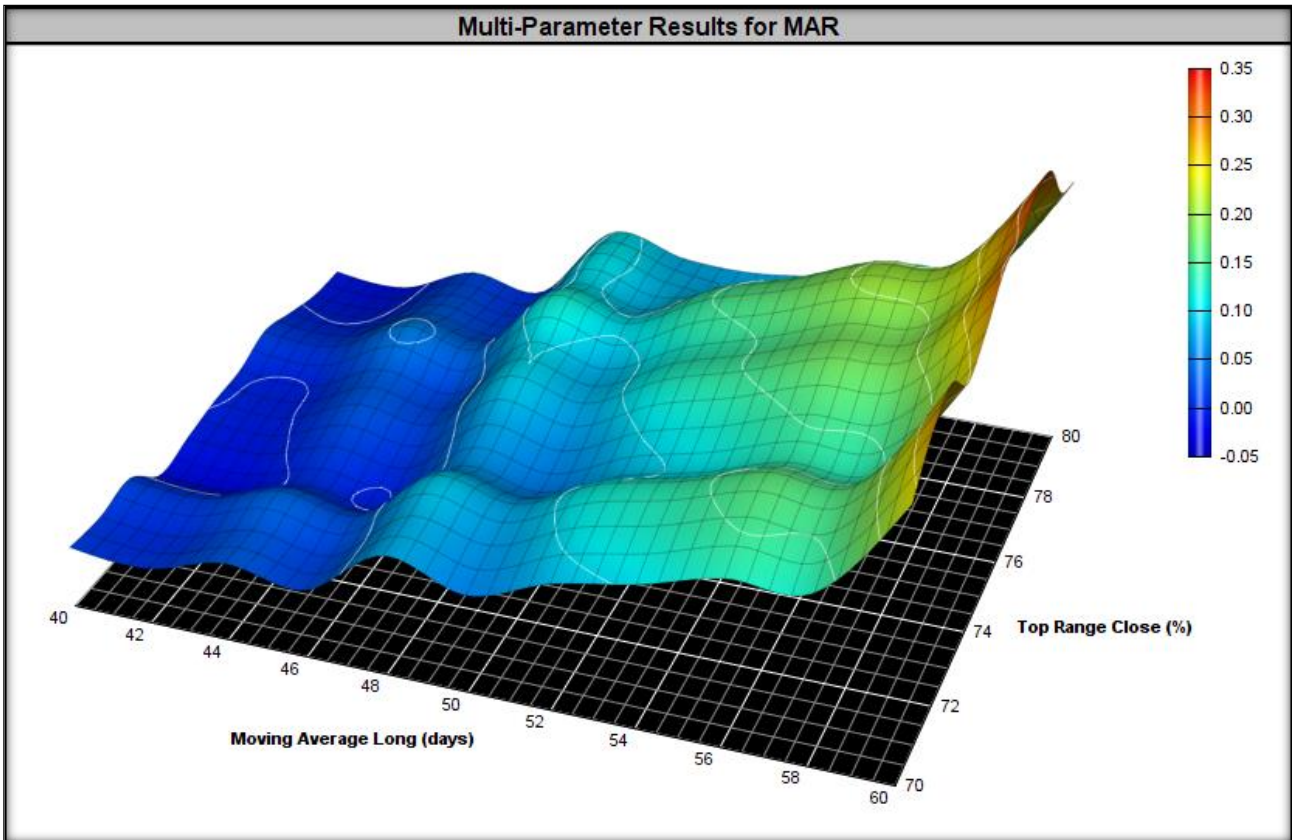


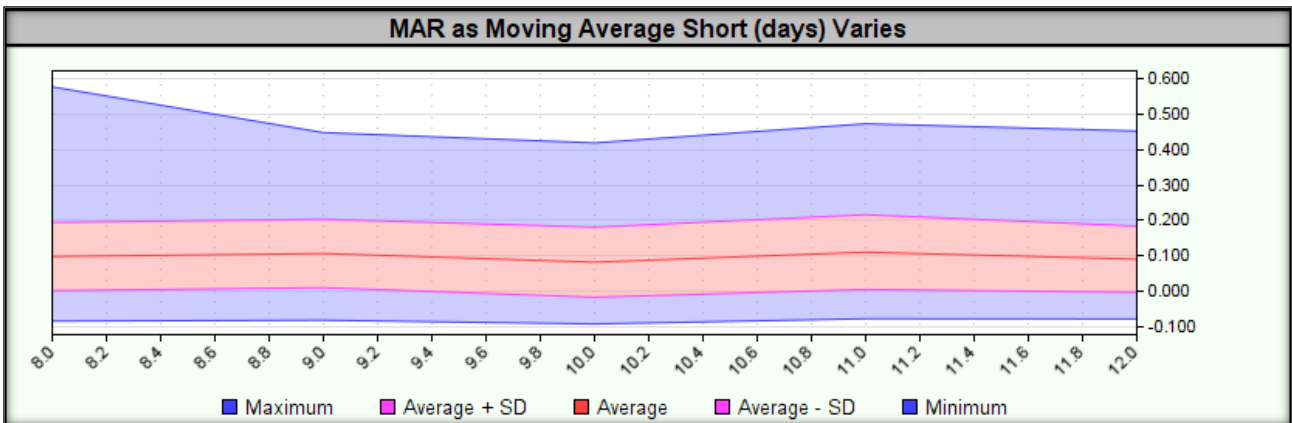
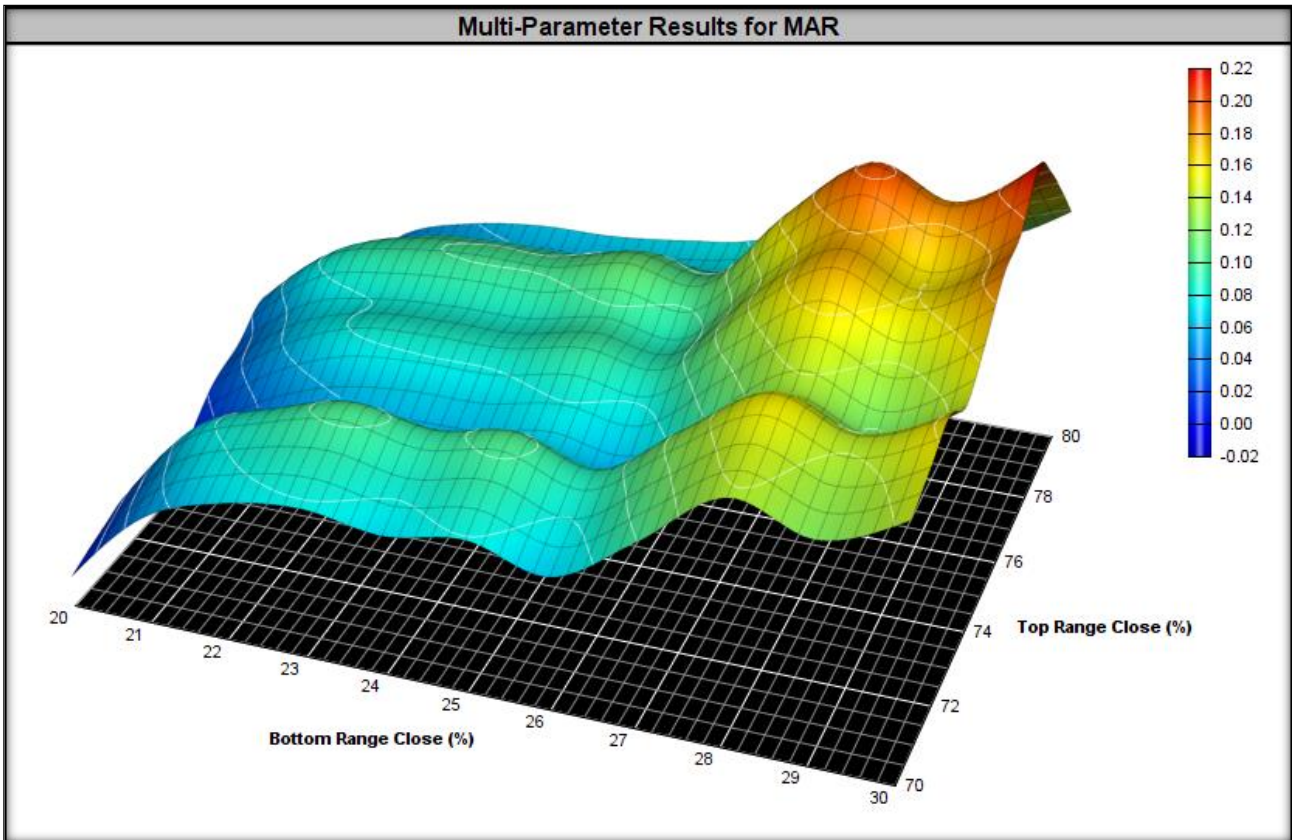


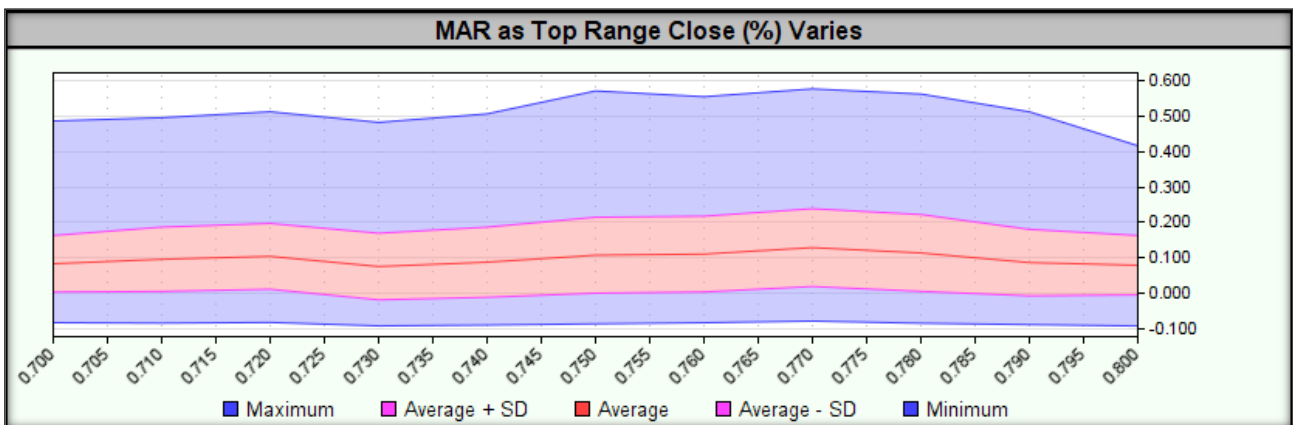
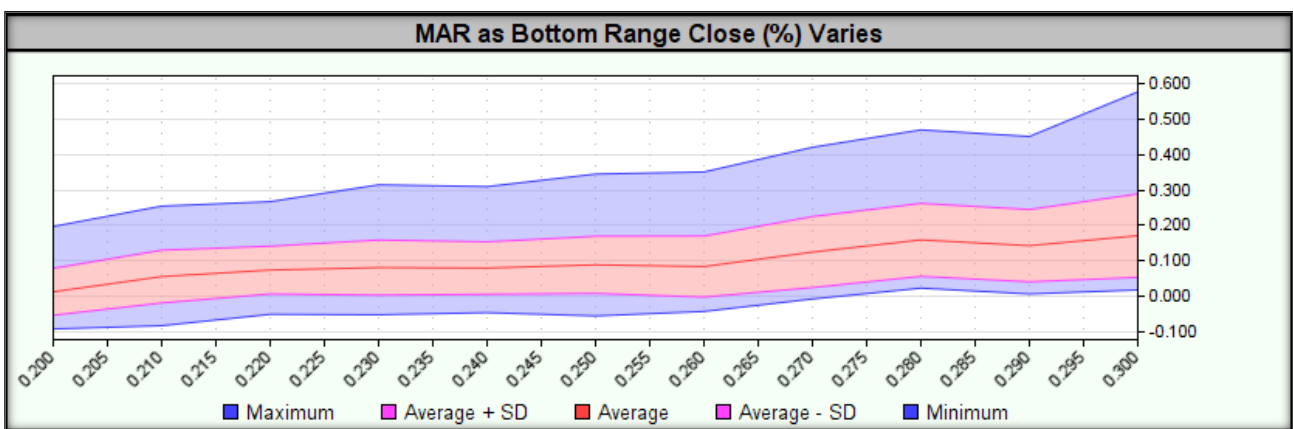
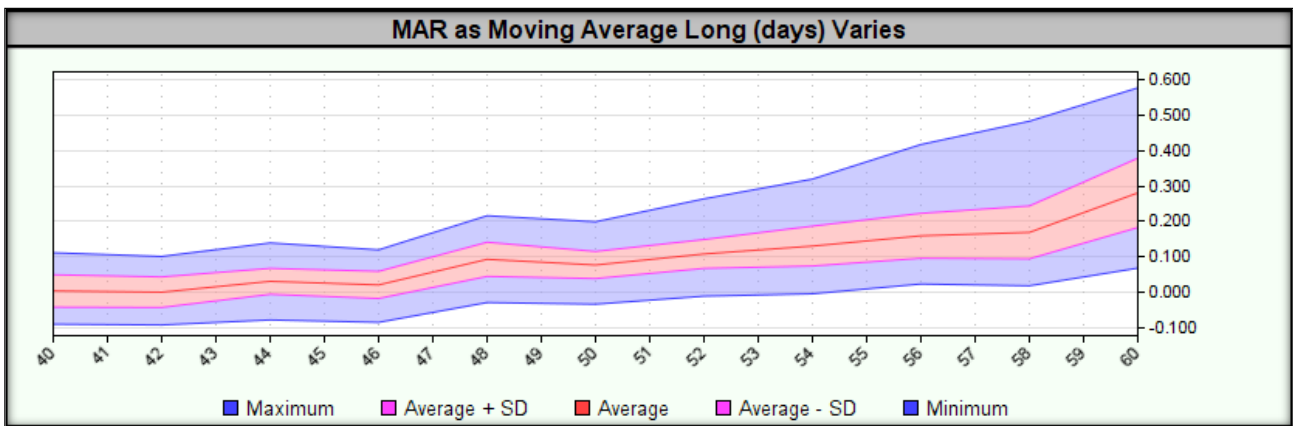












2. Monte Carlo simulation

This step was skipped due to failure of previous stability tests.

3. Stability over a moving time window

This step was skipped due to failure of previous stability tests.

4. Stability long/short

This step was skipped due to failure of previous stability tests.



5. Stability in the portfolio of financial instruments

This step was skipped due to failure of previous stability tests.

6. Money Management (Position Sizing)

This step was skipped due to failure of previous stability tests.

7. Strategy Risk Management

This step was skipped due to failure of previous stability tests.



Step 5: Walk Forward Analysis

Walk Forward Analysis (WFA) is a key tool for assessing a **strategy's ability to perform under real market conditions**. It provides **reliable measures of profit and risk** after the optimization process and allows for answering several key questions:

- 1. What rate of return can you expect from the strategy?**
 - The optimization result often overestimates the expected rate of return, which can lead to unrealistic forecasts.
 - WFA provides a more **reliable and realistic measure of return** by minimizing the impact of overfitting to historical data.
- 2. What set of parameters should be used in the next period?**
 - Thanks to **WFA**, it is possible **to dynamically adjust the strategy parameters to the latest market changes**, increasing its adaptability.

WFA tests the strategy over multiple time periods, which helps **minimize the risk of overfitting** (overfitting the strategy to historical data). The WFA process consists of **two repeated steps**:

- 1. Optimization (In-sample):**
 - The strategy is optimized over a specific **training period (in-sample)**.
 - In this step, parameters are adjusted to obtain **the best results**.
- 2. Testing (Out-of-sample):**
 - The strategy, using **the parameters optimized in Step 1**, is tested on a **test period (out-of-sample)**.
 - This stage verifies the effectiveness of the strategy in new market conditions that **were not used** during optimization.

Walk Forward Efficiency (WFE) is a key measure that assesses whether a strategy has the potential to perform under real market conditions. WFE compares:

- **The rate of return achieved in the in-sample window** (where parameters were optimized)
- **The rate of return in the out-of-sample window** (where the strategy was operating on unknown data)

Similarly, **for the drawdown value**, WFE checks whether the strategy does not lose significant stability outside the optimization period.

A strategy considered **stable (robust) should meet the following conditions**:

- **WFE \geq 50% for the rate of return** – means that the strategy retains at least half of its effectiveness outside the optimization period.
- **WFE \leq 150% for drawdown** – means that the drawdown outside the optimization period is not significantly higher than during the optimization period.

This step was skipped due to failure of previous stability tests.



Step 6: Using the strategy in real time

After **extensive testing**, **implementing a real-time** trading strategy becomes **relatively easy**. Buy/sell signals and **stop loss orders are generated automatically** by the computer based on previously established rules and formulas.

The most important element of **strategy implementation** is **consistent enforcement of all signals, without exceptions**. **How Larry Williams noted:** *"Trading strategies work. Traders do not."*

Before making a **final decision to implement a strategy**, it is necessary to check **whether it really adds value** to the results of the entire portfolio. It does not make sense to implement a strategy that **generates similar signals** or is **characterized by a similar course of the equity curve**.

Key criteria for evaluating the strategy before implementation:

- 1. Daily Return Correlation**
 - The **lower the correlation** with other strategies, the better.
 - **Optimal values:** Correlation close to zero or negative.
- 2. Reducing maximum drawdown**
 - If adding a strategy to a portfolio results in a **lower maximum drawdown**, this is a **strong positive signal**.
- 3. Objective Function Improvement (MAR)**
 - If adding a strategy causes **the MAR to increase**, this indicates that **it has added value** to the portfolio.
- 4. Better results in Monte Carlo simulation**
 - Monte Carlo simulation determines the potential **maximum drawdown**.
 - If Monte Carlo results **improve** after adding a strategy, this is a **strong positive signal**.

The above elements are often interrelated – usually **all of them are met** or **none of them are met**.

Once you decide to add a strategy to your portfolio, **the question arises:** *Should you implement your strategy right away or is it better to wait?*

Some studies suggest **an incubation period** of **3-6 months**, during which:

- The strategy is **monitored** but **does not execute real transactions**.
- **Generated signals, positions and results** are observed to identify **potential anomalies**.

In our case, **the incubation period** lasts from the moment **the strategy is launched in a live environment** until a **drawdown occurs at a level of about half of the maximum drawdown** observed in historical data. **Only after reaching this threshold does the strategy begin to be used with real funds.**

Thanks to this:

- **We avoid investing real money in an untested environment.**
- **We wait for a drawdown to occur** before launching the strategy, which **reduces the risk of starting at an unfavorable moment.**



The final decision to fully implement it should be based on **thorough testing and analysis of the value added to the portfolio**, so that the strategy actually supports long-term investment goals and does not increase unnecessary risk.